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AN EXAMINATION OF DETERMINANTS OF INVESTMENT IN THE U.S. TECHNOLOGY SECTOR- (2003-2018)

AN EMPIRICAL STUDY

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I extend my sincere gratitude to my supervisor, Dr. Paul Hanly for his constant support and guidance throughout the dissertation process. The guidance of Dr. Hanly helped me, not only to explore different aspects that can be considered in creating econometric model, but also helped me developing some salient skills such as attention to detail and research process.

I also thank the Norma Smurfit Library which gave me access to various important literature, which was key to exploring and building the research. I also thank my family and friend for their support throughout the research.

I = Change in investment

Lev = Leverage (Debt-capital ratio)

CF = Free Cashflows

Q = Tobin's Q

INT = Interest

RDEXP = R&D expenses

DW = Durbin-Watson Test

MM approach = Modigliani-Miller Approach

The determinants of investment for a firm differs from the factors which effect the whole economy, this research attempts to determine the influencers of investment in fixed assets of the technology sector in the US. The motivation for this research is that, the technology sector is not an industry where heavy manufacturing takes places and, due to this, it is assumed that, the investment in fixed asset is comparatively less, therefore, this research aims to empirically test what factors affect the investment in fixed assets. Further, it is hypothesized that R&D expenses play a role in determining investment in a company. Thus, the objectives of this research are to, first, determine the factors influencing fixed investment, secondly, to determine the extent to the relationship between the determinant and investment and lastly, to find evidence and R&D expenses of a technology company is a determinant of fixed investment.

1. Introduction:

In quantum physics, it is said that, the laws governing matter behaves different the quantum realm. Just like that, even in economics, the determinants influencing the investment behaviour changes when we go from macro-economic to micro-economic perspective, the factors influencing investment changes. In the macro-economic perspective, investment is predominantly determined by the interest rates and the general income of the public (Blanchard et al, 2017). However, when we dwell into the micro-economic realm, i.e. an analysis of investment of the firm-level, the determining factors change. This study focuses on the industry level investment behaviour of technology sector in the US for the period 2003-2018. It is observed that, the main determinants of investment at firm level are cashflows, leverage, EBITDA etc. and this is evidenced throughout the existing literature as in Mills et al (2001) and Das and Tulin (2017). The research aims to adopt the works done the predecessors and extend it to include a variable which the research hypothesised to have a strong relationship with. The variable is expenses in R&D, the rationale being that, in the technology sector, companies are not involved in manufacturing of heavy machinery and equipment but rather intangible software products. This being the case, it is reasonable to assume that companies in this sector will not be investing heavily on fixed assets but rather in development of intangibles like patents and copyrights.

The rationale for selecting the time period is that, the dotcom bubble burst on 9th October 2002, most of these companies suffered huge market capitalization losses and, in fact, some of the competitors of the sample companies were forced to close their operations. However, these companies recovered quickly by 2003 and had a spell of fine growth period from 2003 until 2008 when the Global Financial Crisis took shape. The recession lasted from 2008-2010 but the global economy was characterized by slow growth and low inflation rate till 2015. Since 2015, the US economy has portrayed an increase in inflation and growth rate. Therefore, when keenly observed, this period represents all four states of the economy. The boom period, the downturn of the economy, the recession period and the recovery of the economy. Thus, it covers all the four probable states in an economy which is beneficial in examining the investment behaviour in all the states of an economy.

Therefore, the aim or the primary objective is to determine to factors which influence the fixed investment behaviour in in US technology sector. Technology sector in this research comprises of the companies involved in developing and

manufacturing of computing devices and software technology. This research will also endeavour to find, to what extent do these determinants affect the industry. Having said that, the unique contribution of this research is determining the purported relationship between R&D expenses and fixed investment and to what extent does it affect the investment. The result is very interesting which will be discussed in the coming sections.

Having said that, it is necessary to inform about the structure of the research. Like all research papers, this study first lays down the foundations for the analysis by overviewing the existing literature and adopting some works of the literature in constructing the investment model. Section 3 goes on to explain the data collected and why the companies that were taken as the sample was selected, i.e. the rationale behind he selection of the sample companies. The paper then discusses the methodology involved in constructing the analyses. This will elucidate the type of approach that the research will be adopting along with the underlying assumptions that are accompanied with the approach. The section following the methodology will be pertaining to model estimation which will evidence from the literature for selecting the variables which will be used in determining the investment level along with the rationale behind the selecting the variables. This section will also discuss about the model validity and the will provide an insight into the diagnostic tests which will confirm that the model complies with all its underlying assumptions. The sector following model estimation will contain the actual analysis and commentary. This paper has not divided empirical results and commentary as separate sections as done in most papers as it would be easier to provide in-depth analysis blended with empirical results. The paper concludes by stating the important findings and the scope for future research.

To summarize, the common theme of all the companies in the sample is that every company is in the technology sector and are research intensive companies. The research attempts to determine the influence of the theorized variables and to what extent will the variable affect the investment behaviour. Secondly, this research will focus on the impact of research in development of IP on fixed investment. Thus, the research will be taking R&D expenses as a proxy to the investment in R&D. The next section outlines and analyses the different literature by different scholars.

2. Literature Review:

There has always been conflicting schools of thought on which are the factors that truly affect the investment level of a individual firm. The central question revolves around what variables, if any , affect investment level in a firm. However, in the real imperfect world, a plethora of factors affect the company's financial decisions. These factors include liquidity, leverage, value of the firm, the length of capital projects and even the age of the firms (Das and Tulin, 2017). This study attempts to determine the financial variables that affects the technology sector in the U.S. The study is motivated by the hypothesis that most technology companies do not invest heavily on fixed capital as most of their products are in the form of software and services rather than actual manufacturing. It is also observed that, the most important capital for these companies is the human capital, i.e. the employees. Therefore, the impact of number of employees is going to play a pivotal role in this study.

Having said that, it would be appropriate to have an overview of the available literature on the determinant of investment in general which will start by the indifference theory of Modigliani and Miller. Then we go on to argue why there exists a considerably strong relationship between investment levels and financial constraints of the firm. The review will also be the source from where we will select the determinant that will explain the investment.

To begin with, in 1958, Modigliani and Miller (1958) proposed that, the value of the firm is not affected by its capital structure and the average cost of capital is also not a dependent of capital structure. However, this seminal paper had its own drawbacks as the theory assumed that, the markets are perfect and information asymmetry does not exist. Thee implications of this paper was that, investment levels of a firm are independent of its capital structure. Although it is, to some extent, right in the 'perfect' world, it is far from truth in the real world. Capital structure of a firm does affect the value of the firm. In fact, in Modigliani and Miller (1960), after inclusion of corporates taxes, it was observed that, the capital structure does have an impact on the company's value and consequently, on the investment level in a company. According to this, the company can be fully leveraged so that it reduces the average cost of capital and thus making the cost of investment projects less expensive.

The works of Modigliani and Miller (1958, 1960) does hold true. However, it does hold true only in a perfect and frictionless economy where there exist no constraints on financing. But, in the 'real' world, a company does have financial constraints, as economics is itself a science of scarcity. Investment decisions are affected by a number of decisions. Right from the profit of the company to the existing capital structure of the company, the company has account for all these factors. In this section, we will discuss the literature pertaining to the factors that affects the investment level in a company.

Fazzari and Lott (1987) approached by using J.M Keynes and Kelecki's work that linked marginal efficiency of capital or the demand with investment levels, that is, when there is an equilibrium between the demand price and the supply price, that will be the appropriate investment level. A company can finance its projects in one of two ways, first, by using the internal cash flow of the firm or, the second, to finance it by external borrowing. The company can only invest to the extent available cash flows without incurring any additional cost of financing. Beyond that investment level, the company will need to rely on external borrowings which will increase the contractual commitments like interest rates. Therefore, there exists a strong relationship between cash commitments and the internal cashflows. With the above logic, the demand price can be a factor of capacity utilisation, internal cashflows and cash commitments or interest rates.

Using the above logic, Fazzari et al (1987) have created a model of firm level investment, taking sales as a proxy for cashflow, the book value of previous investments and interest rate as the independent variables. Therefore, in this approach, unlike the Liu and Pang (2009) approach does not consider the debt component of the business as it is but rather only the cash commitments/Interests payments arising from debts. In this sense, Fazzari et al ignores the impact on investment by debt overhang.

Gilchrist et al (1998) considers the marginal profitability of capital (MPK) the most important and almost the sole determinant of investment levels in a firm. However, as MPK is difficult to measure, most often empirical literature takes average return on capital as a proxy measure. Incidentally, this proxy measure also serves as a good measure of financial health of the firm, which under real-world market scenarios influence investment. They predict the MPK with vector autoregressions and determine the investment level suitable for a company.

Mills, Morling and Tease (2001) on the other hand, look at the relationship between the financial factors like cashflows, leverage and monetary policy, stating that, a change in the interest rate will affect the cashflows of the company and change the discounting rate of the investment. Thus, the monetary policy of an economy will affect the corporate sector. They further go on to state that, in a perfect capital market, the only determinant of cost of capital/investments would be the interest rates, since in a perfect market, availability of cashflow is a restraint on the investment and thus, financial factors do not directly affect the cost of capital. However, we, of course do not live in that world where everything is perfect. In this world, cashflows have an important effect on investments, especially for small firms where the investment decisions depend on the level of liquidity. Another aspect is that, even large companies will try to finance their investment through internal funds, as external financing increases the financial stress on the company and will involve costs like bankruptcy costs and agency costs. If suppose, a company finances an investment through equity, it is losing control over decision making as it dilutes the ownership.

Liu and Pang (2009) argued debt also plays an important role in a firm's investment decision as high leverage involves agency, bankruptcy costs and high leverages also implies that greater proportion of interest payments will be there, and this will reduce the cash flow. Hence, investment depends on the existing and the previous levels of debt and should be included in the model. In other words, refuting the MM Approach of 1960, Liu and Pang (2009) observed that, too much debt can lead to increasing adverse effects like the one stated above.

Further, Liu and Pang (2009) start building the model by stating that, the output of a company is directly proportional to company's firm investment level. Citing this, they have taken sales/revenue in lieu of the cash flow of the firm. Building on to this model, following the logic that the company's previous investments are likely to affect the present level of investment, they have considered investment variable of lagged one time-period. Further, to capture the effect of growth over time, change in output at time t and change in output at time t-1 are incorporated.

In Liu pang (2009), it was observed that, large scales companies were less affected by cashflows as a determinant of investment that small and medium scale companies. Likewise, debt was also exhibiting the same characteristics where the beta of large firms was just -0.106, whereas, for small and medium

scale, the beta was -0.125 and -0.146 respectively. This revealed that, as the firms get larger, the effect of debt of the firms reduces.

Sonali Das and Volodymyr Tulin (2017) in an IMF working papers finds that, the problem of under-investment arises partly due information asymmetries and agency cost. Further, under-investment is also induced by debt overhang, that it can impact the investment level. Moreover, high debt translates into high value of the company, which will cause agency problems since the investment decision-makers would choose a negative investment over a positive one. Therefore, the empirical model they constructed was of three variations, the first, consisting of leverage ratio/debt-equity ratio along with control variables like, sales to capital ratio, cashflow to capital ratio and the logarithm of capital stock at the beginning of the year. The second variation was an extension of the first estimation model, which included the concept of an open economy, including the effect of exports and imports of the economy. To capture the effect of previous trend, the model variables are lagged to previous one period. The third variation focuses on quit a novel variable, that is the project length. It was observed that project length is also a factor that is considered while undertaking investment decisions. Since, if the time taken to actualise an investment takes a considerable time, the liquidity and the cashflow of the company is blocked for some period of time. Therefore, it is expected that, the time taken to complete the project, if longer, induces underinvestment.

In a very recent research article, Jin and Zhao (2017) studied the effect of over-credit on investment in the Chinese economy. In doing so, they observed that, apart from the positive statistically significant relationship of cashflow with investment, it was also evidenced that the age and the size of the firm had a negative relationship with the investment. However, it should be noted that the coefficient of age was not statistically significant, but it should not be disregarded as it had a negative relationship. This revealed that, smaller firm are more inclined to invest more as they are in expansion stage of the company life cycle.

To summarize, the investment level of a company cannot solely be determined by the average cost of capital as Modigliani and Miller (1958) suggested. The investment of a company is determined by a plethora of factors like cashflows, leverage involved in the company, agency costs and many more. In specific to this research, it poses an interesting question of whether the determinants cited and suggested in the existing literatures has the same predictive power when it

is applied the technology industry. This is of particular interest as, most of technology firms are big multinational companies who are self-sufficient and cash-rich having no liquidity problem. That being the case, will the same conventional models have a significant influence on investments is the question. That is why these literatures will influence the current study, in order to find out the primary determinants of investment in fixed assets. However, there is one more variable that can affect level of investment in a company. That variable is the Tobin's Q which we will be exploring in the next section.

Tobin's Q is a ratio between market value of the enterprise and the average cost of replacing capital. In other words, it is a single ratio that shows whether a stock of a company is undervalued or overvalued. Theoretically, the Q of a company should be equal to one, if the Q is more than one, the stock is overvalued. Conversely, if it is less than one, it is undervalued. The Tobin's Q of a company is very good indicator to the investors in having a fair idea of the true value of the share. Tobin (1969) suggested the investment level of a firm is positively correlated with the ratio between market value the enterprise and the average cost of replacing capital. The rationale behind this is, as Mishkin (1996) explains, if the Tobin's Q is higher, it implies that, the investors are prepared to pay more than what the share's worth and this will encourage the company to invest more, since, in layman's term, the company gets more than what they bargained for. Conversely, if the Tobin's Q is low, the company would realise that, even if they rise finance through equity, it could not cover even the cost of replacing capital. In other words, if the Tobin's Q is high, the inducement to invest is high. But, the point of conflict among academics has been that, whether the market valuation of a company really matter when it comes to investment decisions. Many economists are of the view that, it is not the Tobin's Q but Fundamental Q (the ratio between the intrinsic value of firm calculated using internal cashflows and the average cost of replacing capital) that matters. The discussion below outlines the various argument put forth by the different literatures.

Blanchard, Summers and Rhee (1993) take a dynamic approach by linking the stock markets with the investment level in a firm. Blanchard takes Tobin's Q as the parameter to value the company in terms of the market. Blanchard goes to state that, if it is to be assumed that the asset markets value the firms based on the fundamental value alone, then, the valuation of a 'marginal project' will be in line with the market valuation of the firm or Tobin's Q. In other words, if the

markets represent the intrinsic value of the firm then, the value of one individual investment project and the market valuation of the entire firm will be positively correlated.

However, most of the times, the fundamental valuation differs from the market's valuation. This can be attributed to 3 main reasons, first, the firm has greater access to information hence it is far more accurate, second, the firm's value in the market is undergoing a speculative bubble, or the market is subjected to 'fads' for a longer period of time which is resulting in differed valuation. But, the real question is, what 'value' should the managers take into account while investing in an investment project (Blanchard et al, 1993).

To this aspect, there are two opposing arguments. First, which was argued by Bosworth (1975), states that, the managers should ignore the valuation by the market as the valuation by the managers is the expected present value of future cashflows discounted by the riskless rate. By this, he implied that, the firm should set the investment level to that level, where the marginal product equals the riskless rate. The second argument, posed by Fisher and Merton posits that, regardless of the fundamental value the managers should consider the market value of the firm while determining the investment level. Their rationale was that, if the market is ready to accept a lower rate of return, the optimum rate of investment should be the level at which Q is equal to that rate of return. Conversely, according to Fisher and Merton, if the Q is more than one, the managers should issue a greater number of share and invest till it drives the Q back to one (Blanchard et al, 1993).

Using this premise, Blanchard et al (1993) models the optimum investment level as a function of the fundamental Q and the Tobin's Q. Applying this model to the data pertaining to U.S firm from 1900-1990, they found that, both the market Q and the fundamental Q is strongly influence the investment levels, but, the impact of the fundamental Q is a lot significant than the market Q (in terms of R Squared). However, when the regression equation mentioned was altered to profit and fundamental Q and the independent variables, the results varied showing that the profits have a much greater predictive power than fundamental Q. This shows that, financial variables such as profits and cashflows have a greater influence on investment than Tobin's Q. But, on the other hand, investment can be more relatable with fundamentals of the company rather than market valuations.

The study by the Bakke and Whited (2010) echoed the finding of Blanchard et al (1993). It was tested whether the investment of a firm depends on the market movement and mispricing of the company's shares. The result of this study was that, in care of large firms, the mispricing of the share is irrelevant for investment decisions and have a weak significance to with firms having financial constraints. However, the price informativeness does have an impact on the investment decisions.

To further support the stance that, the market Tobin's Q is not appropriate, Das and Tulin (2017) conducted a study of Indian investment scenario observes that, aggregate gross fixed capital formation stock had decreased from growth rate of 12 percent a year through last decade year ending 2011-12 to 3.5 percent a year for the last five years. However, at the same time, the leverage of Indian corporates has shown an upward trajectory giving room for questioning the extent to which financial frictions are constraining the private investment. The paper shifts the focus from Tobin's Q to firm fundamentals, arguing that, academic works like Gales and Gomes (2013) observe that Tobin's Q, in fact has very weak relations with optimal investments and that too under strict assumptions. Moreover, using firm fundamentals as investment determinants mitigates the risk of stock misevaluations which may distort the optimum investment level.

As regards to the relationship between marginal q (average of Tobin's Q) and investment, Bolton et al (2011) observed that, the marginal q and investment follow the direction if the firm is financing its projects using cash or internal sources of funding but, on the other hand, if the investment is financed by external borrowings, the relationship between the marginal q and investment is inverse. In other words, investment has direct relationship with leverage, as it delays the investment, in the case of decrease in leverage, to delay the issuance of equity. In Bolton et al (2011), it was also observed that, financially constrained firms actually have lower equity beta, by contrast of the expected high equity beta. The rationale for the 'paradox' is that when a company is financially constrained, they tend to hold more assets in cash, which has zero beta.

In conclusion, the Tobin's Q is a measure pertaining to the market valuations of the firm's value which has quite weak correlation with the investment level in a firm. On the contrary, it is found in Blanchard et al (1993) that the fundamental Q has more correlation as an investment determinant. The technology sector companies such as Apple, Alphabet, Netflix etc. are often overvalued by the

market due to market exuberance. The question in this context is that, whether the market exuberance is just noise of the investors or does it truly affect the investment decisions taken by the firm. In addition, it is known that, interest rates and Tobin's Q is inversely correlated, and interest rates have a direct impact on the investment levels of a firm. Therefore, is there any influence of Tobin's Q in the investment level given that interest rates are direct influencers of investments is the question here.

Having discussed about Tobin's Q, we will move on to see the role of uncertainty on investment decisions and how the 'perceived' value of waiting for more information changes the investment level in a company. The next section deals with the element of uncertainty and information asymmetry.

In the real world, businesses are often faced with uncertainty and risks from all front. Having said that, often, companies must evaluate an investment decision under limiting circumstances, especially under limited information. This, coupled with a certain extent of uncertainty causes companies to be inclined to delay the projects involving high capital expenditure. The companies wait for more relevant information on the project to be relatively more certain of the outcome of the big investments. This is what we will be discussing in this section, regarding the perceived value of information and at what point is it optimal to go ahead with the investment decision.

To start with, Bernanke (1983) looks at the determinants of investments from a new perspective, where uncertainty plays a pivotal role in determining the investment level. It observes that, if the investor/decision-making body sees that, a future probably information flow has considerable value, the body will tend to postpone their commitment to invest. This is influenced by the fact that, an investment made cannot be 'undone', that is, an investment is irreversible and, this can cause reluctance of investment fearing the uncertainty of future cashflow. This causes underinvestment as managers tend to wait for the right amount of information to act on but lose this ideal opportunity. Though this is a valid observation, it will not form part of my research as my research does not narrow on the uncertainty element as a standalone determinant.

Similarly, Dixit and Pindyck (1996) have echoed Bernanke's approach of considering investments as options and that, the option of postponing the investment decisions in anticipation of new information has value. It observes

that, the simple NPV decision is based on two faulty assumptions, first being that, investment decisions are reversable, that is, if the market condition become worse off, then the firm can nullify the investment without any significant extra costs. This assumption is flawed as, investments in advertising and marketing, for example, are sunk costs. The second assumption is that, it is a 'now or never' situation if the investment is deemed to be irreversible. This, it was observed, limits the decision-making 'opportunities'. When investment opportunities are viewed as options, under the constraints of irreversibility and uncertainty, the behaviour of firm investment changes drastically. As manager perceive waiting for new information as an option that has value and not as a 'now or never' opportunity, it changes the dynamics of investment decision-making as the timing of the investment plays a pivotal role.

In this light, it is noted that, Liu and Pang (2009) observed that, one of the major influencers of underinvesting is information asymmetry, that is, the lack of information regarding the uncertainties cause the managers to become risk averse and not investment. Likewise, the corporate managers are not entirely indifferent to the source of financing, while external financing causes dilution of ownership, internal financing retains the level of ownership intact. Hence, the liquidity of the firm is one big influencer in determining the investment level in the firm.

The downside however, is that, in case of the 'now or never' scenario of NPV, it induces the management invest regardless and contribute to the economy's growth, but in case of considering investments as options, there is an inducement to postpone for better certainty and this leads to underinvestment.

Thang (2014) focuses on the drivers of investment with special emphasize on uncertainty in specific to the Australian firms. The result of this study was that, there exists a negative relationship between investment and uncertainty, but having said that, the study also states that the impact of uncertainty on the firm's investment also depends on its size and that the strength of the relationship is depends on the market power that the firm commands and the degree of its other financial constraints.

The empirical model begins by a simple one explanatory variable, that is Q, the ratio between the market value of the capital of a firm and the cost of replacing capital. Ideally, that is, in a frictionless perfect market, the Q ratio should be a sufficient explanatory variable that can reflect all the available business opportunities. However, in the real imperfect world, other financial variables are

in play that can impact the firm's investments choices. In addition, the is a perceived value for the option to delay the investment. As the uncertainty increases in the market, the value of option to delay increases and firms will only invest if the returns are likely to be greater than the value of the option. Therefore, for this study, Thang (2014) built a model comprising of three explanatory variables, the Q of the firms, a vector variable comprising of sales ratio and leverage ratios and the variance to capture the uncertainty involved in investment decision making.

Although the notion that, companies only invest when the investment returns exceed the value of the option to postpone valid, the flip side of the argument is, a firm cannot continuously postpone an investment opportunity without any cost attached to it. Firm is high-paced competitive environment, if the opportunities are not sized as and when they are presented, the growth opportunities will start to decay and thus the value of the firm itself declines (Fazzari, 1993).

Thus, with uncertainty and variability as a determining factor, it further elucidates investment behaviour of the firm and how it adversely effects the investment decisions by postponing the investment projects due to lack of uncertainty. However, in my study, which takes 15 of the biggest technology firms in America, almost all the big technology companies are cash-rich, hence, variability and uncertainty affects them little. Therefore, in my model, uncertainty will not be an explanatory variable. Further, it is known that, unlike manufacturing firms, technology companies do not invest heavily on fixed assets and machinery. Having said that, it is important acknowledge and note the fact that uncertainty can be a defining variable in other industries like oil and mining where the profitability depends on the market price of the commodity.

Although we have considered cashflows as the source and determinant of investment, it should be noted that the working capital is also a source of internal funds which the company can use in times of financial distress rather than postponing the entire investment project. We will briefly have an overview on the logic of why it is better to include working capital as a source of financing investment in the next section.

Having said that, it is also noteworthy to observe that working capital can be considered as a source of funding an investment. For instance, the inventory

materials/components go directly into the production function of the firm. Unlike Pindyck (1991) which emphasizes irreversibility of investment, working capital is a lot more liquid in the sense that it can be used as collateral for short-term borrowings. Due to the reversable nature of working capital, it can be used to smooth out the fixed capital investment (Fazzari, 1993). To illustrate this, Fazzari and Petersen (1993) explains an instance where there is negative shock of the cashflow and due to this, the firm may have to reduce the level of asset accumulation across all asset classes (fixed and current), but due to irreversibility of fixed investment projects, the firms should not cut the rate of investment proportionately. The firm should allow the working capital investment to bear higher amount of losses and adjustments costs. This way, the working capital becomes a source of funds for the firms facing short-term cashflow constraints.

The result of including the working capital to the fixed investment regression equation is a negative co-efficient asserting the fact the cashflow and investment have positive coefficients not just because of cashflow being a proxy of investment demand.

As per this, the company should prioritize the use of funds and give importance to the capital expenditure even if it is at the cost of the working capital losses. This is because, an increase in capital will prove to be an investment which propels the future growth of the company. Further, the fluid nature of financing will provide a relaxation to the company in terms of financing the project. Having said that, it is equally important to focus on the timing of investment as the returns are subject to market conditions and other uncertainties.

Having gone through various pieces of literature, we have come to understand the nature and the determinants of investment. Firstly, it has been observed that, the investment behaviour at a firm level does not depend solely on the average cost of capital as proposed initially by Modigliani and Miller (1958). On the contrary, it has found through extensive empirical literature, as in the works of Mills et al (2001) and Liu and Pang (2009) that, the investment behaviour depends on a number of internal factors such as leverage, cashflows, debt overhang etc. It is also noteworthy to remember that, the investment behaviour of a firm is also distorted by the agency costs among other qualitative factors.

Secondly, though it is true that, the Tobin's Q has impact on firm's investment level. However, through recent literature, it has not only been proved as not being the sole determinant of investment as Tobin (1969) claimed, but also been found in Blanchard (1993) as a weak explanatory variable compared to the fundamental Q. As Blanchard (1993) suggests, the reason for the weaker correlation is that, the market value of the enterprise in question will be distorted by the market exuberance and depressions. The literature rather suggests that, instead of Tobin's Q, the fundamental Q should be a determinant of investment as it possesses far greater predictive power.

Lastly, we also found evidence in literature that suggests, the uncertainty and variability involved will affect the investment behaviour of a firm. As the market is filled with information asymmetries, investment decision by the firms are often delayed in pursuit for more information to make more informed decision to be certain of return of investment. This perceived value of waiting for new information delays the investment, which causes slowdown of investment.

In fact, we can go on to say that, intangible assets and intellectual property (IP) forms the bulk of the investments by technology companies. This implies two points, first being that, if they companies use a bulk of their retained earnings and borrowings on developing new IP, it naturally implies that, the investment in IP is done at the expense of investment in fixed assets. Secondly, the resource that power the development of the IP are people, i.e. human capital. Therefore, the problem on a macro-economic perspective occurs when, income generation is disproportionate to the capital employed to fuel the consumption. This leads to the public developing an attitude of saving. This is evidenced in Figure 2 of Section 6, where the figure clearly shows the widening gap between the change in R&D expenses and the change in fixed asset investment.

So, in essence, this study's unique contributing factor is the examining and analysis using a model which employs the some of the determinants evidenced in the literature plus a special on R&D expenses as a determinant of investment. This R&D expenses will serve as a proxy to both the investment in intangibles assets and also the expenses rendered by employing highly skilled professional actualize the R&D. Thus, the research is based on the hypothesis that, with every dollar spent for R&D, there is a dollar less for fixed asset investments.

3. Data:

For the purpose of this study, we have taken 16 companies from the technology companies from the US from the year 2003 to 2018. The data collected is quarterly in time frequency. These companies are the biggest names in technology and software industry. The data collected are the following:

- Investment in Fixed Assets
- Free Cashflows (FCF)
- Tobin's Q
- Research & Development Expenses
- Debt-Capital Ratio
- GDP per capita
- Interest rates

The sixteen companies that is in this study represents the totality of technology sector. The companies the study has taken as samples are; *Amazon, Google, Facebook, Microsoft, Netflix, Apple, Cisco Systems, Qualcomm, eBay, Activision, NVIDIA, Entertainment Arts, Adobe Systems, Intel Corporation, Cognizant Technology Solutions and Oracle Corporation.*

The rationale for selecting these companies is that, in terms of market capitalization, these companies make up the bulk of the total capitalization of the sector, thus giving a wholistic view of the sector. Secondly, as the primary of the study is to determine main influencing factors that affect investment in fixed assets, these companies are research intensive and some of the companies, in their initial years grew with very limited fixed investment. Thirdly, the investment made by these companies are predominantly in improving the efficacy of a certain software or search engines, in other words, a bulk of the investment go to the upgradation or invention of new intangible assets. In order to do so, these companies need not invest heavily on plant and machinery, but rather human capital. It can be argued that, companies such Oracle or Amazon will investment building large databases, yes, these company do invest in building databases, but it should be noted that the frequency of building databases is comparatively lower than the investment brought in by other sectors. Fourthly, almost half of the companies the sample is cash-rich, having no problem of liquidity or cashflows, thus, it will be interesting verify whether the same determinants the existing literature supports holds good for US technology sector. As we will see in the following sections, there are few very interesting findings that differ from the conventional determinants.

Lastly, if the study is going to be based on US technology sectors, these companies are some of the big names that have revolutionized the world in many different ways. Hence, if the study going examine the determinants investment in technology sector, it is almost mandatory to include these names.

These data were collected from a paid service website called www.ycharts.com where, the historical financial datasets of every listed company are available. The macro-economic variables were collected from the Federal Reserve of Economic Data (FRED). These datasets will be used as a part of model building. In the following section, we will progress to basic analysis of the variable involved and how they are correlated with each other.

4. Methodology:

The primary aim of this research is to determine the factors affecting and influencing investments in the Technology sector and also determine the extent to which the determinants influence the investments in fixed assets. This can be done by regressing the independent variables and observe whether the variables affect them investment significantly enough to be a factor. Having said that, it is observed from the existing literature that, the investment of a firm is influenced by a number of factors. Some of the factors being, the leverage of the firm, the cashflows generated and other macro-variables like interest rates and Tobin's Q.

The research employs quantitative research methodology. The study uses panel data constructed by obtaining data pertaining the variables which are used in the model of 16 companies in the technology sector as mentioned in Section 3. The data of the 16 companies are consolidated by averaging them on a quarterly basis. The averages are taken to samples representing the technology sector. The averages are the data around which the predictive model is built. As mentioned earlier, this study will be building a model which will determine the extent to which the investment of technology firms in the US is effected by the variables in the model. For this end, we will be performing multi-variate regression analysis.

What is a regression analysis in the first place? A regression analysis is a predictive modelling model which throws light into the relationship between the independent and the dependent variable. This kind of analysis is used to forecast or determine whether there exists a causal effect relationship between the variables. This helps to determine the strength of the relationship and to what extent can an occurrence of an event be explained as a cause of changes in other variables.

Now that we chose the method of analysis, we can discuss the intricacies of the regression equation. Since the primary objective is to determine the factors and the extent of their influence, the study frames two regression equations where, the first will focus on the internal factors such as cashflows, leverage and other firm-specific variables. The result of the first equation will be analysed and studied. Then, with the variables which are statistically significant in the first equation, the study will construct the second equation by extending the equation by adding the macro-economic variables. This process will allow us to compare the coefficient of determination between the first and second

equation. Thus, it will allow us to analysis the R-squared of the two regressions to determine whether, there is an increased explanatory power when the macro-economic variables are included and if so, by how much. The macro-economic variables that the study will use are interest rates and GDP per capita. The rationale for selecting the variables are discussed in the next Section, Model Estimation.

In this study, linear regression will be employed. In other words, the method of least squares will determine the investment in this piece of study. The rationale for using this technique is that, the objective of the study is to find how frequent does investment change when one of the variables changes. In order to do that, it is necessary to observe how much does the actual observation differ from the estimated line of best fit, and by doing so, the causal relationship can be estimated. Therefore, for this study, the best technique of regression is the Ordinary Least Square (OLS) method.

Having concluded that the best method is OLS, the study also notes that the OLS regression is based upon some assumptions. They are:

- Linearity: The OLS regression assumes that the relationship between the dependent and independent variables are linear.
- Normality: This assumes that, the dependent variable of the model is normally distributed.
- Multi-collinearity: In a linear regression model, it assumes that, there exists no multi-collinearity among the independent variables.
- Auto-correlation: This assumes that, the variables are not subject to autocorrelation, meaning that, the variable are not correlated with previous values of the same variable.

The tests for verifying whether the model satisfies the above assumptions will be analysed in Section 4. In conclusion, for this study, OLS Regression technique is used to determine the extent the independent variables affect the investment level in fixed assets. The next section will provide an insight in the construction of the model and the validity of the same.

5. Model Estimation:

Having discussed the relevant literature, we can now build a model that best describes the investment behaviour in the high-tech industry in the U.S. The motivation for studying the determinant of investment in the U.S technology sector is the fact that, after the Financial Crisis, despite a series of quantitative easing programs, the world economy, specifically, the U.S economy did not seem to grow at the expected rate forecasted by the economists. Summers (2016) states that, it may be that the economy has entered into a phase of secular stagnation combined with the hysteresis effect on the economy due to slowdown of consumption rate. Further, in Summers (2014) it was observed that due to automation and technological advancement, companies in the technological arena become much more valuable with relatively less capital borrowing and investment. This motivated me to investigate the determinants of investment in technology sector in the US. Therefore, the primary aim of this research is:

- To determine the factors that have an effect the investment behaviour of the companies in the technology sector.
- If so, to determine to extent to which these factors play a role in determining the level of investment.
- Thirdly, to determine whether the R&D expenses have an effect on the investment.

5(a). Internal firm factors:

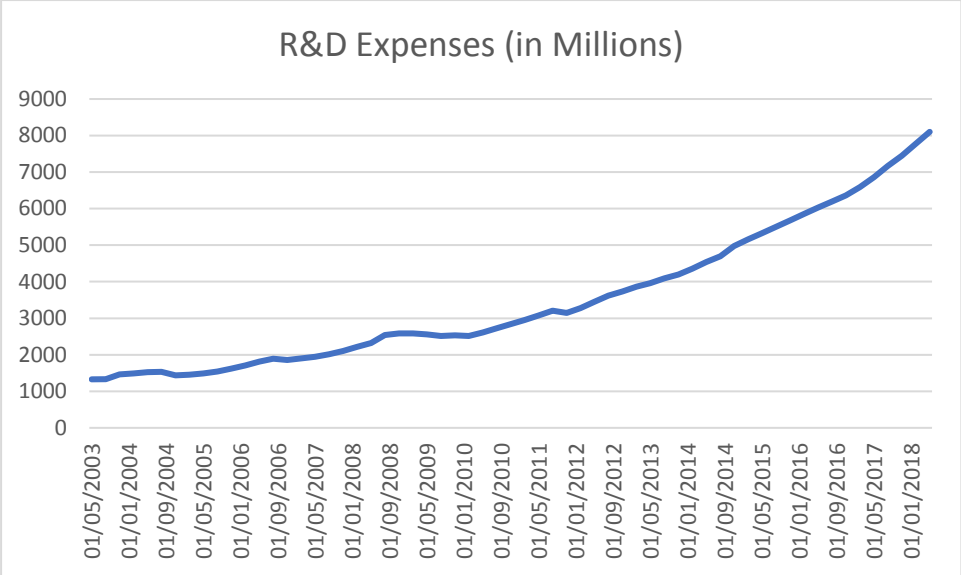
Having clearly stated the objective of this study, we can proceed to discuss about the model that best explains the investment behaviour. For the purpose of this study, we will first try to explain the investment as a function of internal factors. From the literature, it is observed that, the internal factors such as leverage, cashflows and even the capital spent for investment in previous time periods describe the present investment level. Following the literature, in this study, the investment level (I) will be a function of:

- The logarithm of industry average free cashflows (CF)
- Debt-to-capital ratio (Lev)
- Market Tobin's Q (Q)
- The logarithm of Research and Developments

The rationale for selecting these variables as the dependent variables are discussed below:

- Free cashflows: As observed in Mills (2001), cashflows of a company shows the liquidity and how financially constricted the company is. Further, a corporation will prefer internal financing compared to rising equity or borrowing funds. This is because, when it finances an investment with its own funds, there is no dilution of ownership and external financing involves high agency costs, bankruptcy costs and other costs which can be avoided if the company finances through its internal finances. Having said that, it can be hypothesized that the cashflows and the rate of investment share a directly proportional relationship i.e. investment increases as cashflows increases. However, it cannot be said that, it cannot be said that, if cashflows increase, the investment will definitely increase as the rate of investment is determined by various other factors. Logarithm of the cashflows are taken as the cashflows of the sample companies are very skewed.
- Debt-capital ratio: In the imperfect world, leverage is one of the main deciding factors of investment. this is because unlike the MM approach, the management has to take into consideration costs like agency and bankruptcy costs. The company, hence has to balance between stakeholder's and shareholder's interests. Moreover, it was observed in Liu and Pang (2009) that, the overhang of debt of the previous time periods influences the present investment behaviour. The reason for debt overhang can be traced back to capital structure decisions and the inherent cost to fund bankruptcy. Although, most corporates are inclined to finance their investment through their own internal funds, most often that is not the case and companies are forced to rely on external borrowing which in turn increase the risk borne by them. Hence, debt-capital ratio or leverage is important.
- Tobin's Q: Though the literature states that Tobin's Q has a weak relationship, it does not necessarily mean that, the relationship should hold true for the technology sector. One school of thought is of the view that managers should ignore the fundamental value of the firm and take the market value alone for making investment decisions. Therefore, this model does consider the Tobin's Q as one of the explanatory variables for this study.

- R&D Expenses: The inclusion of this variable the value added by this research to this existing literature. The importance this variable is specific to the technology and software industry. The reason being, this industry has been investing in research heavily. This can be understood better with a visual perspective:



Graph (1)

As it can be observed, at the start of 2003, the average R&D expenses of all 16 companies was only over $1.3Bn, however, by the mid of 2018, the average spending of each company rose close to $8.2Bn. This means that, the proportionate amount of money is not being utilized by the firms to invest in fixed assets. Although, there is economic benefit to the whole economy in investing in intangible intellectual property, this benefit is of long term in nature. The immediate benefit to the economy, i.e. one that helps the economy to gain momentum is investment in fixed asset. Thus, the primary hypothesis is that R&D expenses has an inverse relationship with investments in fixed assets.

Following the literature, it can be concluded that, these four factors are sufficient to explain the investment behaviour of the technology industry in the US. The reason being, the study has considered all the possible perspectives that could impact a company's investment decisions. That being, corporate capital structure (Debt-capital ratio), liquidity of the company (free cashflows) and the role of market seasonality in investment decisions (Tobin's Q) and R&D expenses which is an addition to the existing literature. thus, the study will be limiting itself to these four variables as far as the internal factors are concerned.

However, the study will include macro-economic variables to understand the extent of impact they have on the investment behaviour at the firm-level.

5(b). Macro-economic factors:

Having discussed the model, we will extend the current model to include macro-economic variables and have an insight into the impact of the macro-level indicators on the tech sector in the US. The two variable this study will be focusing on is GDP per capita and the Federal interest rates. The reason for this, is that, the GDP per capita captures the mood of the country's economy as GDP comprises of the total goods and services produced by the economy during the said period. Further, the GDP also includes the investments and the government spending in the country's economy, including the impact of imports and exports. Thus, the GDP per capita provides the 'eagles-eye' view of the economy. Having said that, it is noteworthy to mention that the interest rates also play an important role in the economy. Mishkin (1996) observes that, when the interest rates are low, the cost of capital reduces as the borrowing costs of funding the investments are cheaper. This induces the investment by corporates. Again, Mishkin (1996) elucidates the relationship between the interest rates and assets which again links back to the concept of Tobin's Q. The rationale is that, when there is a reduction of interest rates, the economy gets heated and there is more money in the hands of the public, because of which, public/investors will invest more in the stock markets which will, in turn, cause an increase in the asset prices thus overvaluing the market value of the company in the stock market. This will cause the Tobin's Q to increase and encourage the corporates to invest more. Thus, in theory the relationship between the interest rates and Tobin's Q of a company is that of an inverse relationship. This study also investigates whether, in the technology sector of the US economy, can the investment level be explained solely through interest rates and the industry average of Tobin's Q and if there exists a relationship, to what extent.

In line with the objectives stated above, the model proposed will be a multi-variate model consisting of only the Tobin's Q and the federal interest rate and lagged log of cashflow. This inclusion of cashflow ensures that the model takes into account for liquidity issues that could have an impact on the model.

$$\Delta I = \alpha + \beta_1 Q_{t-1} + \beta_2\, lev_{t-1} + \beta_3 CF_{t-1} + \beta_t RDEXP_t \qquad \dots\dots (1)$$

Where, I= Investment in fixed assets (% change in Net PP&E),

Q_{t-1} = Industry average of Tobin's Q

lev_{t-1}= Logarithm of Debt-Capital Ratio

CF = Free cash flows for the firm

RDEXP= Research & Development expenses

Next, we will include another macro-economic variable, that is, GDP per capita. This will reveal the extent to which GDP per capita affects the change in investment rate. Thus, the model extends the model by making lagged variables of log of cashflows, log of GDP per capita and interest rates explanatory variables.

$$\Delta I = \alpha + \beta_2\, lev_{t-1} + \beta_t RDEXP_t + \beta_4 INT_t + \beta_5 GDP(per\ capita) \quad \ldots\ldots (2)$$

Where, INT = Interest Rate

This model focuses more on the macro-economic variables and its effect on the investment behaviour at a firm level perspective. The study has included the logarithm of cashflows to modify the macro-economic relationship in respect to the technology sector as the cashflows are the average of the 15 biggest technology companies in the US. In addition, cashflows is an important determinant in firm-level investment behaviour.

5(c). Model Diagnostics:

Having described the model, it is of paramount importance to perform diagnostics on the model to test the validity of the model. An appropriate regression model is one that satisfies all the assumption on which OLS regression technique is built on. As mentioned in Section 3, the assumptions pertaining to the OLS regression model are; linearity, normality, no autocorrelation and no multicollinearity. To this end, the study will first conduct the requisite tests to verify whether the model complies with the assumptions of the regression technique to ensure that the model is appropriate and strong predictor of investment levels. We will conduct the diagnostics in the following order:

Multi-collinearity:

Multi-collinearity is the property where two variables are considerably correlated and are linear to one another, in specific to regression analysis, multicollinearity refers to the scenario where two independent variables are significantly correlated. This will hinder the results of the model as the correlation between the variable will cause distortion in the regression results. The measure of collinearity can be a correlation matrix, tolerance or Variance

Inflation Factor (VIF). The study will be using the VIF as a measure of multicollinearity which is calculated using SPSS. The below table shows the diagnostic results for multicollinearity:

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Debt-Captal (t-1)	.160	6.249
	Industry average Tobin's Q (t-1)	.501	1.996
	R&D Expenses (Log)	.071	14.017
	Log CF (t-1)	.116	8.643

a. Dependent Variable: Investment (% change)

Collinearity Diagnostics[a]

Model		Eigenvalue	Condition Index	Variance Proportions				
				(Constant)	Debt-Captal (t-1)	Industry average Tobin's Q (t-1)	R&D Expenses (Log)	Log CF (t-1)
1	1	4.909	1.000	0.00	0.00	0.00	0.00	0.00
	2	0.078	7.954	0.00	0.01	0.35	0.00	0.00
	3	0.012	20.276	0.02	0.22	0.09	0.00	0.00
	4	0.001	79.756	0.44	0.35	0.48	0.00	0.55
	5	0.000	148.572	0.54	0.42	0.08	1.00	0.45

a. Dependent Variable: Investment (% change)

Table (1)

The main figure that should be noted is the VIF, this diagnostic is done with five percent confidence interval, which means that, a VIF of more than 5 indicates a moderate level of multicollinearity. Likewise, a VIF above 10 is clearly indicates a strong multicollinearity. It should be observed that, research & development expenses show a VIF of 14.07 which is comparatively high but, considering that cashflows is affected by increase or decrease in R&D expenses, it is unavoidable to frame a model with no collinearity whatsoever. Further, As observed in Table 1, none of the variables has a VIF exceeding 10, however, cashflows are debt-capital ratio exceed 5. The shows, there exists a slight degree of multicollinearity among logarithm of debt-capital ratio and log of cashflows. It is to be expected as, as debt increases, the interest upon the borrowings also increases explaining the proportionate change in the cashflows. One another reason could be that, as borrowing increases, the cash inflows in the financing activities increases,

thus having a logical correlation between the two. Having said that, the other variables are well under the limit.

Auto-correlation:

Autocorrelation refers to the correlation of the data points of a variable with its own predecessors. This will, like the multicollinearity issue, distort the regression results. Thus, a linear regression has to assume that, the dataset is not autocorrelated. To examine this assumption, the study will employ the Durbin-Watson test which is on a scale of 1 to 4, 2 being that the dataset is totally uncorrelated to its predecessors. A value above 2 indicates a possibility of a positive autocorrelation, likewise, a value below 2 indicates the dataset may be negatively correlated. Having said that, it is reasonable to have a value between 1.4 to 2.6. The table below shows the Durbin-Watson diagnostics value along with the R-Squared of the model.

Model Summary[b]

Model	Durbin-Watson
1	1.451[a]

a. Predictors: (Constant), Log CF (t-1), Industry average Tobin's Q (t-1), Debt-Captal (t-1), R&D Expenses (Log)

b. Dependent Variable: Investment (% change)

Table (2)

As seen in the table above, the Durbin-Watson diagnostics resulted a value of 1.451. This means that, there exists an evidence of negative autocorrelation among the dataset to some extent. This is reasonable evidencing the literature, where Liu and Pang (2009) observed that, a determinant of investment is debt overhang. This means that, the previous levels of debts affect the present capacity to borrow which in turn affects the investment level since investments need funds. Further, since, as already observed that, the cashflows and the leverage are slightly correlated, it deduces to cashflows also being autocorrelated to some extent. Thus, it is absolutely reasonable to expect the Durbin-Watson value to evidence negative correlation.

Normality:

This assumes that, the dependent variable should be in line with a normal distribution. This is because, if the dependent variable is skewed, the skewness will distort the interpretation of the regression result. It is a common and preferred practice to normalise the data by taking the logarithm of the data. That is why, in this study, the cashflows and debt-capital ratio are logarithms. The common tests for testing normality are the Kolmogorov statistics and Shapiro-Wilk tests. In this study, Shapiro-Wilk statistic will be used to determine normality. The table below shows the results for normality test.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Investment (% change)	.062	61	.200*	.986	61	.701
Debt-Captal (t-1)	.133	61	.009	.927	61	.001
Industry average Tobin's Q (t-1)	.101	61	.192	.954	61	.023
R&D Expenses (Log)	.087	61	.200*	.950	61	.014
Log CF (t-1)	.112	61	.055	.962	61	.057
Interest rate	.368	61	.000	.617	61	.000
Change in GDP per capita rate	.146	61	.003	.869	61	.000

*. This is a lower bound of the true significance.

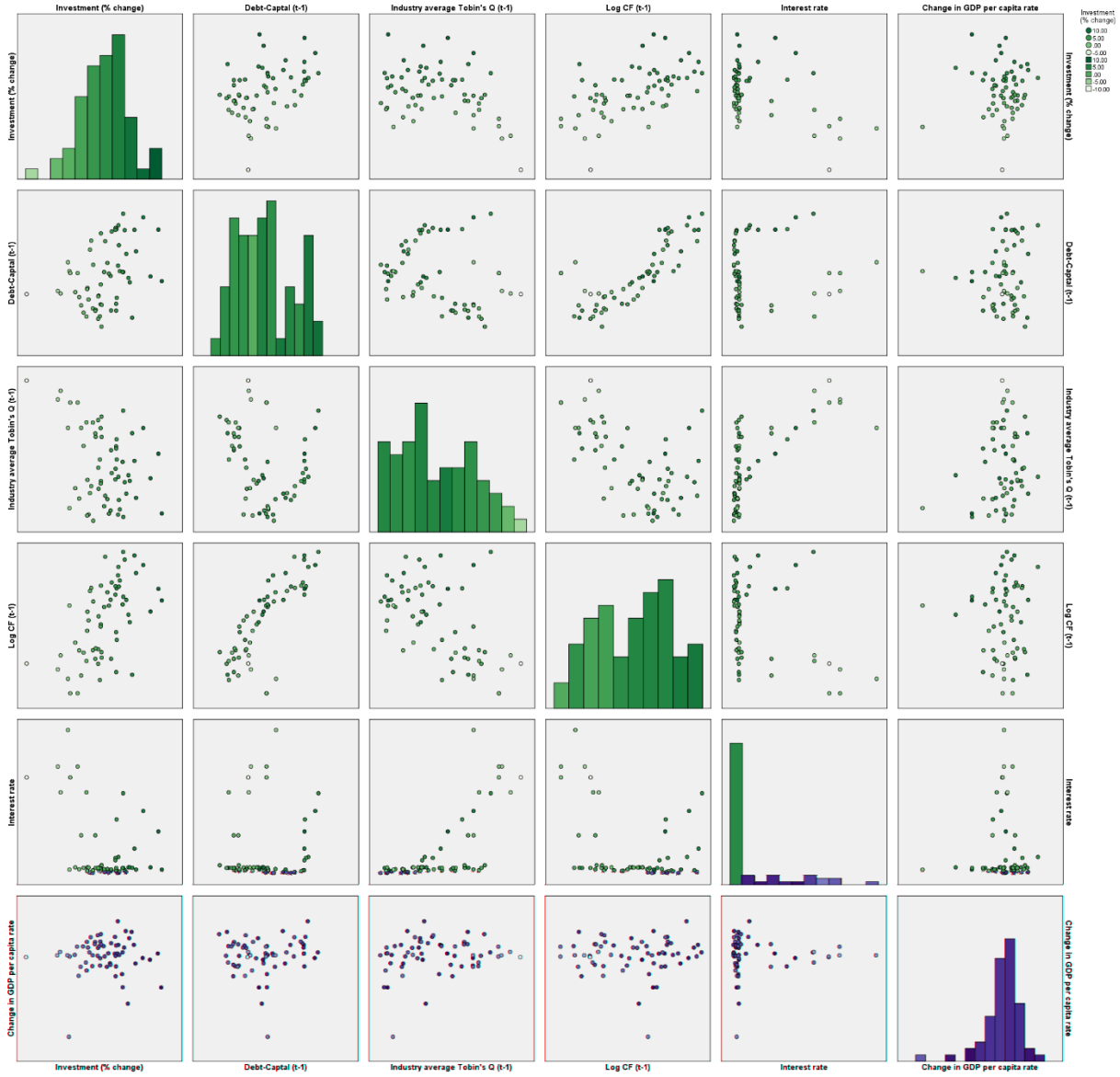
a. Lilliefors Significance Correction

Table (3)

The observation from the table clearly shows that the dependent variable is 0.701 which is more than the 0.05 mark that Shapiro-Wilk test uses to determine normality. It is seen that even the logarithm of cashflows is normally distributed which may be due the logarithm which normalized it. Further, it is not surprising that interest rates and the GDP per capita is not normally distributed as, interest rates and GDP of the US plunged spiralling downwards during the years 2008-2010 and interest rates continued to plunge down till 2015 due to QE program. The normality test most important for the dependent variable of the model which is change in investment. The normality test is passed as the Shapiro-Wilk diagnostics exceeds the 0.05 value.

Linearity:

Linearity refers to the fact that, the variables in the model are linear to one another. This is important especially for the OLS method of regression as this method depends on the distance between the expected value and the predicted value. In other words, the predictive power of the regression depends on the assumption that, the variables are linear in nature. This can be tested using the linearity graphs.



Graph (2)

The graphs when observed, shows that, most of the variables are linear with varying degrees of linearity. Having said that, it should be noted that, only the variable-pair, investment change-leverage and investment change-Tobin's Q are the one showing randomness to certain extent.

Thus, to summarize, in the model built for this study, there is some extent of multicollinearity but is very negligible. This correlation between the variables is predominantly present in internal factors and is because of the nature of the firm which is reasonable to expect. As regards to autocorrelation, the DW test value is 1.420 which means that, there exists, to some extent negative autocorrelation. But, this is bound to happen, since, as already mentioned, previous level of debt is a determinant of the present level of debt. Therefore, the value of the DW test is expected. Thus, there is bound to be a certain negligible amount of multicollinearity and autocorrelation, but this is inherent in a model where the independent variables are financial matrices of a firm.

5(d). Limitations of the Model:

No study can be sans limitations, and this research is no different. There are few limitations to this model. They are:

a. This model does not consider the impact of the size and age of the sample companies. In the existing literature, there is evidence that the age and size of the company is an important determinant of investment. Initially, EBITDA was included as a proxy to size of the firm but had to be excluded as the multicollinearity value appeared exceedingly high.
b. Even when the model was modified, there seemed to be relatively high multicollinearity value for R&D expenses. But, as R&D expenses formed the core of the model, it was unavoidable to exclude it.
c. The sample taken for this study comprises of the big names in technology sector and hence does not capture the effect of these determinant on small and medium scale companies. However, the results of this research are perfectly valid for well-established firms with global presence.

The limitations stated above are the known acknowledged ones, though, it may be few other limitations. To overcome the first limitation, the study has included EBITDA (lagged by one time period) as a variable for analysis in the descriptive and correlation sub-sections of the next section.

5(e). Conclusion

Having had an overview of the model specifications and the rationale behind the selection of the determinant, it is safe to assume that the model satisfies all the conditions of a linear regression model. The model attempts to identify the extent of influence the determinants have on investment in fixed assets in technology sector. Thus, the model is spilt into two, one consisting only of

internal factors and the second, extending the first model to include the macro-economic variables. The following section leads to the analysis and rationale and will be divided into 3 subsections, Descriptive statistics, Correlation matrix and Regression results.

1. Empirical Results and Analysis:

Having stated that model and methodology to be followed, the study will now dwell into what relationship does the seemingly random datasets have and how it defines the investment behaviour of the technology sector in the US. While it is known that EBITDA is not part of the analysis, it is observed that, EBITDA is an important matrix in evaluating the impact on investment. the reason why EBITDA is not included in the regression model is because of the fact the cashflows and EBITDA exhibited exceedingly high levels of multicollinearity. Further, it must be noted that, for the purpose of descriptive analysis and correlation matrix, the debt-capital ratio is kept in its original form and not as logarithm. The logarithm of debt-capital ratio is only used in the regression model as it needed to be normalised. Having said that, we will now interpret some basic statistics in the following sub-sections.

6(a). Descriptive statistics:

In any research, it is vital to understand nature of variables involved in analysis. Thus, it is essential to grasp the basic statistics of the same. Below shows the descriptive statistics of all the variables involved in the analysis:

Percentage change in Investment in Fixed Asset	
Mean	3.571323
Standard Error	0.382801
Median	3.508324
Mode	#N/A
Standard Deviation	2.989773
Sample Variance	8.938744
Kurtosis	0.928165
Skewness	-0.28683
Range	16.35017
Minimum	-5.86509
Maximum	10.48508
Sum	217.8507
Count	61

Debt-Captal (t-1)	
Mean	0.375704
Standard Error	0.00818
Median	0.368547
Mode	0.375273
Standard Deviation	0.063891
Sample Variance	0.004082
Kurtosis	-0.79275
Skewness	0.576732
Range	0.236648
Minimum	0.280928
Maximum	0.517576
Sum	22.91792
Count	61

Log of EBITDA (t-1)	
Mean	3.860475
Standard Error	0.033776
Median	3.893658
Mode	3.421477
Standard Deviation	0.263799
Sample Variance	0.06959
Kurtosis	-1.36084
Skewness	-0.20903
Range	0.865882
Minimum	3.401699
Maximum	4.267581
Sum	235.489
Count	61

Industry average Tobin's Q (t-1)	
Mean	2.686061
Standard Error	0.095982
Median	2.5202
Mode	3.940538
Standard Deviation	0.749641
Sample Variance	0.561961
Kurtosis	-0.89567
Skewness	0.358783
Range	2.82259
Minimum	1.561764
Maximum	4.384354
Sum	163.8497
Count	61

Log CF (t-1)	
Mean	3.136146
Standard Error	0.032954
Median	3.174017
Mode	2.646738
Standard Deviation	0.257379
Sample Variance	0.066244
Kurtosis	-1.0621
Skewness	-0.10528
Range	0.948479
Minimum	2.646738
Maximum	3.595217
Sum	191.3049
Count	61

Interest rate	
Mean	0.486
Standard Error	0.087
Median	0.178
Mode	0.188
Standard Deviation	0.680
Sample Variance	0.463
Kurtosis	3.141
Skewness	2.016
Range	2.878
Minimum	0.075
Maximum	2.953
Sum	29.635
Count	61

Change in GDP per capita rate	
Mean	0.274
Standard Error	0.077
Median	0.337
Mode	#N/A
Standard Deviation	0.602
Sample Variance	0.362
Kurtosis	6.570
Skewness	-1.862
Range	3.878
Minimum	-2.452
Maximum	1.425
Sum	16.722
Count	61.000

Table set (4)

While understanding the nature of the dependent variables, the most important aspect is the average and by how much the data point vary from the average, that is, the arithmetic mean and the standard deviation of the variable. This shows the at what level the variable has been during the time period in question and by what extent does data point of a determinant fluctuate. The internal determinants have been lagged by one period of time in order to capture the effect of previous actions by the firm. Having explained the important of these statistics, we will study the nature of these variable before going into the analysis of the same.

Starting with percentage change in investment, it is observed that, during the period 2002-2018, the investment in fixed assets have, on an average increased by 3.5% per year with significant variation compared to other variables, that is, by almost 3 standard deviation. This can be due the fact that, all the industries were hit badly during the Financial Crisis of 2008 and that, the investment in fixed assets are the first thing the company will try to reduce in times of distress. Having said that, it is also worthy to note that, the mean leverage of the technology industry during the period under scrutiny is relatively moderate of 37.8% debt-capital. Further, there seems not to be any significant borrowing during this period as the standard deviation of debt-capital ratio is very low at just 0.0638 standard deviations which is very close the actual mean.

Thus, through this, we can deduce that, while the fixed investment has gone through some ups and downs, it cannot be as a result of variations in the debt level since, the debt level throughout the industry has remained fairly consistent.

Progressing now to the internal determinants of the firm, which is EBITDA and cashflows. We observe that, these two determinants can be explained perfect in relation to each other. The logarithm average of EBITDA is slight higher than its counterpart of cashflows at 3.864 and 3.132 respectively. This is logical as cashflows is a derivative of EBITDA and is bound to be lower. Coming the standard deviation, it is unsurprising that, it is almost the same for the two as, the EBITDA and cashflows are strongly related and can be said that if EBITDA changes, the cashflows will also change proportionately. However, EBITDA appears more negatively skewed at -0.209 than cashflows which is at -0.105. this shows that cashflows are more normally distributed than the EBITDA. This can be because of the fact that, the EBITDA is affected by the cyclical movement of the entire economy whereas, the cashflows can be controlled to some extent by reducing the operational cashflow movements and by reducing the dividend pay-out.

Having analysed the determinants which are endemic to the firm, we now analyse the determinants which are focused to the market and the macro structure of the economy. Rather unsurprisingly, the average interest rate during the years 2002-2018 is just 0.480 which is understandable given the state of the economy in 2008-2009 and its sluggish recovery in 2015 when the Quantitative Easing program stopped. However, it is noteworthy to observe that the industry average of Tobin's Q remained fairly high at 2.69. This means that, despite the years of depression, the companies of the technology sector have fairly remained a good investment in the eyes of the public as it is, on an average market valued at 2.69 times of the cost of replacing capital. Meanwhile, the GDP per capita has been growing steadily over the years with a change in GDP per capita mean of 0.274. it is rather surprising that, as it was observed, the standard deviation of the GDP per capita is relatively low at 0.604 standard deviation given that, the GDP of US fell considerably during the recession years.

Having discussed the nature and their relationship between the some of the variables, it is now appropriate to analyse the correlation of each of the variable and how it can have an effect on the investment model. The next subsection will

overview the correlations of the variables in question with the help of a correlation matrix.

6(b). Correlation Matrix:

A correlation matrix shows the correlation between the variables, which helps us have a fair idea of how the determinants are related to each other and to what extent. The table below gives a summary of correlation along with their means and standard deviations.

Correlations								
		Investment (% change)	Debt-Captal (t-1)	Log of EBITDA (t-1)	Industry average Tobin's Q (t-1)	Log CF (t-1)	Interest rate	Change in GDP per capita rate
Investment (% change)	Pearson Correlation	1	.387**	.626**	-.365**	.563**	-.433**	0.034
	Sig. (2-tailed)		0.002	0.000	0.004	0.000	0.000	0.795
	N	61	61	61	61	61	61	61
Debt-Captal (t-1)	Pearson Correlation	.387**	1	.819**	-0.234	.800**	0.093	0.117
	Sig. (2-tailed)	0.002		0.000	0.069	0.000	0.475	0.370
	N	61	61	61	61	61	61	61
Log of EBITDA (t-1)	Pearson Correlation	.626**	.819**	1	-.614**	.953**	-.410**	-0.015
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.001	0.907
	N	61	61	61	61	61	61	61
Industry average Tobin's Q (t-1)	Pearson Correlation	-.365**	-0.234	-.614**	1	-.569**	.690**	0.176
	Sig. (2-tailed)	0.004	0.069	0.000		0.000	0.000	0.176
	N	61	61	61	61	61	61	61
Log CF (t-1)	Pearson Correlation	.563**	.800**	.953**	-.569**	1	-.362**	0.007
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.004	0.959
	N	61	61	61	61	61	61	61
Interest rate	Pearson Correlation	-.433**	0.093	-.410**	.690**	-.362**	1	0.026
	Sig. (2-tailed)	0.000	0.475	0.001	0.000	0.004		0.843
	N	61	61	61	61	61	61	61
Change in GDP per capita rate	Pearson Correlation	0.034	0.117	-0.015	0.176	0.007	0.026	1
	Sig. (2-tailed)	0.795	0.370	0.907	0.176	0.959	0.843	
	N	61	61	61	61	61	61	61

**. Correlation is significant at the 0.01 level (2-tailed).

Table (5)

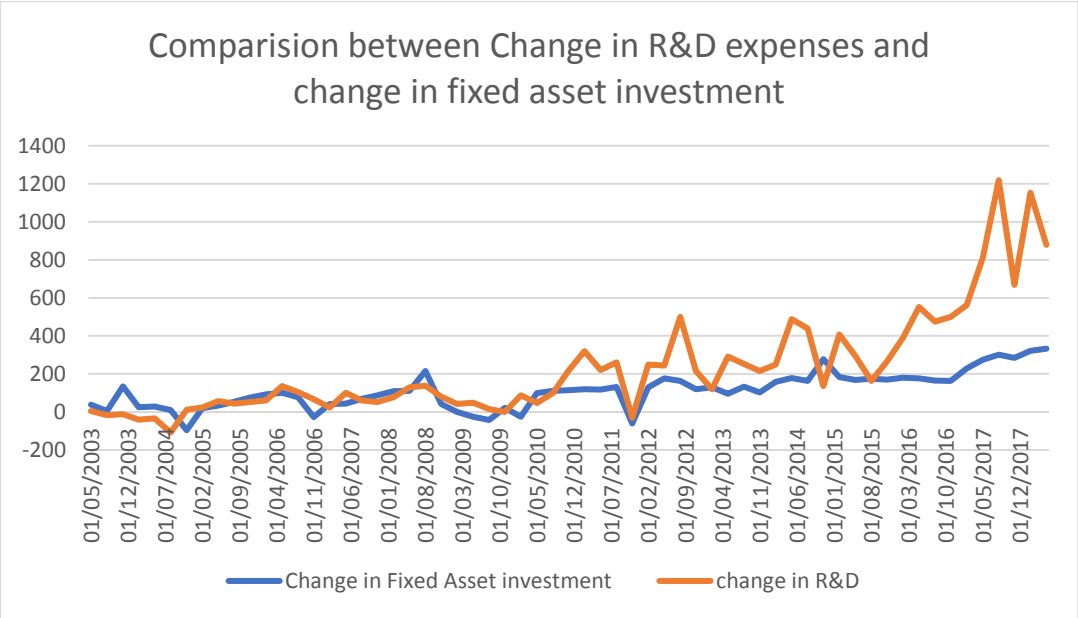
A keen observation of the matrix shown above reveals quite a number of conclusions. Firstly, in terms of the relation between the dependent and independent variable, none of the dependent variable has a significantly high

correlation co-efficient, highest being between (1) and (3) which is 0.63. All the three internal determinants of investment have considerably moderate explanatory power with respect to the change in investments, revealing that internal determinants are more relevant in terms of explaining investment behaviour. the irony is that, in theory, there should be a positive relationship between investment and Tobin's Q. The rationale is that, when there is an increase in the Tobin's Q, the cost of replacing capital becomes relatively cheaper and will incentivize the company to increase investments. However, as the table above shows, there is a negative relationship between change in investment and Tobin's Q of -0.365. This could be because of the popularity of technology companies due to its high growth potential, causing investment having a 'craze' over these shares thereby causing the market value of the company to inflate. However, this does not necessarily mean that when Tobin's Q is high, the investment should always increase, as the market value of a company most often is a product of the white noise surrounding the intrinsic value of the share. Further, it is observed that the GDP per capita of the economy has little correlation with the investment level.

Likewise, the debt-capital ratio is observed to be highly correlated with the logarithm of EBITDA and the logarithm of cashflows which is 0.812 and 0.8 respectively. This can be explained, as higher the debt increase, the cashflows of the company increases proportionately as borrowing in the cashflow statement resulting in a higher correlation between the two. Likewise, the relationship between EBITDA and debt-capital is similar. As the debt increases, the company has more funds to expand and increase their sales which, in turn, will cause the EBITDA to increase. Having said that, it should be mentioned that, the relationship between the debt-capital ratio and the macro economic variables (GDP per capita and Tobin's Q) are not that strong. The reason can be that, while there are few fluctuations in the GDP per capita, there is literally very little fluctuations in the debt-capital ratio cause the two to have a weak relationship.

An interesting dynamic to discuss is the relationship of Tobin's Q and both cashflows and the EBITDA. The relationship between these two pairs of variables is that of negative, which -0.612 and -0.562 for EBITDA and cashflows respectively. This result does not make sense, when the Tobin's Q increases, in theory, the cashflow and EBITDA decreases which is shown in the negative nature of the relationship but, the cause of decrease in cashflows should be an increase fixed investment. However, from the previous section, we find that,

Tobin's and change in investment share a weak relationship. So, what could be the cause of the negative relationship? There are two possibilities, first being that, companies engage in stock buybacks in order to consolidate the ownership in the company. The best time to incentivize the investors to sell their shares are when the stock prices are high, and high Tobin's Q is a direct indication of high market share of the share. the second possibility of that, the company directly its earnings and cashflows to non-fixed investment like research and development or intellectual property. The below table shows the level of the investment gone into fixed asset and research and development expenditure:



Graph (3)

From this graph, we understand the anomaly, that though Tobin's Q is weakly correlated with percentage change in fixed investment, EBITDA and cashflows have much stronger negative relationship with the Tobin's Q. The reason being, the companies are surely incentivized by higher Tobin's Q, but they tend to invest more on research and development expenses rather than fixed expenditure. Figure (1) clearly shows the widening gap and increase in change in R&D expenses which is in stark contrast with the relatively flat change in fixed investment. This is why the paradox exists.

Having said that, it is interesting to note the relationship of interest rates with rest of the variables. With investment change in fixed assets, logarithm of cashflows and EBITDA, interest rates have a negative relationship with the correlation co-efficient hovering between -0.35 and -0.44. This is understandably since, if, when the interest rates decrease, it will encourage

investments, but also decrease the cashflows in form of interest expenses. However, what is most interesting that, when Tobin's Q and interest rates should, in theory, have an inverse relationship, but in this study, it has a positive correlation co-efficient of 0.69. This bring to the conclusions that, first, the technology companies are well sort after that, even when there is an increase in the interest rates, there is still demand for these technology shares. Or, it can be that, during the period the study is focused on characterized the worst financial crisis which brought the interest rates to rock bottom along with most of the economic activity down including investment in shares. Due to this, investors might have exercised caution and reduced their investing activity which coincided with lowering the interest rates.

In conclusion, the correlations between the variables fit the theoretical rationale in some cases. The GDP per capita however is very weakly correlated withal other variables.

6(c). Regression Results:

Now that we have an overview of the nature of variables and their correlations, we now can proceed to the regression model. This study examines the regression model in two parts. First, we examine the influence of internal factors which is endemic to the industry and the firm. After this, we extend the model to include interest rates and (change in) GDP per capita. This will allow us to know the influence of macro-economic variable of the industry's investment decisions. These regressions are modelled with 5% confidence intervals

Results:

First, the study will run a regression modelled with the determinants endemic to the industry. In this first regression model, the study will include logarithm of Debt-capital ratio, logarithm of cashflows, logarithm of R&D expenses and the Industry average of Tobin's Q as the dependent variables. These four dependent variables will be used to determine the investment level at the firm level in the technology sector.

In any regression analysis, the important aspects that determine the extent to which the independent variables are affected are the R-Squared or Coefficients of determination, Coefficients or the Beta and the p-value or the significance of the dependent variables. Before we analysis the regression, we must first understand the different aspect that is mentioned above. First, the R-Squared is

the proportion of variance that, the independent variable can be explained or predicted by the variance in the dependent variable. In other words, R-Squared shows, by how much the dependent variable is explained by changes in the independent variable. Secondly, Beta or coefficient informs on how the independent variable are related to the dependent variable. For instance, a positive beta indicates that when there is an increase in the independent variable, there is an increase in the dependent variable as well. Conversely, if the beta is negative, it means that, where there is an increase in the independent variable, there is a decrease in the dependent variable. Further, the value of the beta signifies the magnitude of influence an independent variable has on the dependent variable. For example, if the beta is 2, it signifies that, when there is an increase of independent variable of, say 4%, the dependent variable will increase by two percent. The beta allows to examine the impact of the independent variable on the dependent variables in isolation.

Lastly, p-value is equally important as it informs the user whether the beta of the independent variables is due to causal effect relationship or whether the beta is as a result of randomness and spurious correlations. The p-value, in essence determines whether the relationship between the dependent and independent variables are due to any inherent correlations due to certain relationship or, is it because of mathematical randomness. When the confidence interval is 95 %, the threshold limit of P-value will be 0.05. This means that, a p-value that exceeds 0.05 signifies that, there is a probability that the relationship between that particular pair of independent and dependent variables is caused by randomness and there is no particular causal relationship.

Having discussed the important aspects of a regression result, we can go in the analysis. The empirical results are shown below:

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Log CF (t-1), Industry average Tobin's Q (t-1), Debt-Captal (t-1), R&D Expenses (Log)[b]	.	Enter

a. Dependent Variable: Investment (% change)

Table (5)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.650[a]	0.423	0.382	2.35082	0.423	10.262	4	56	0.000	1.451

a. Predictors: (Constant), Log CF (t-1), Industry average Tobin's Q (t-1), Debt-Captal (t-1), R&D Expenses (Log)

b. Dependent Variable: Investment (% change)

Table (6)

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	226.849	4	56.712	10.262	.000[b]
	Residual	309.475	56	5.526		
	Total	536.325	60			

a. Depedent Variable: Investment (% change)

Table (7)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound
1	(Constant)	-40.749	9.968		-4.088	0.000	-60.719	-20.780
	Debt-Capital (t-1)	-31.981	11.874	-0.683	-2.693	0.009	-55.768	-8.193
	Industry average Tobin's Q (t-1)	0.430	0.572	0.108	0.752	0.455	-0.716	1.576
	R&D Expenses (Log)	14.802	4.898	1.149	3.022	0.004	4.991	24.613
	Log CF (t-1)	1.159	3.467	0.100	0.334	0.739	-5.785	8.103

a. Dependent Variable: Investment (% change)

Table (8)

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-2.5705	6.6008	3.5713	1.94443	61
Residual	-6.72622	5.53999	.00000	2.27111	61
Std. Predicted Value	-3.159	1.558	.000	1.000	61
Std. Residual	-2.861	2.357	.000	.966	61

a. Dependent Variable: Investment (% change)

Table (9)

The analysis starts with interpreting the beta and the corresponding p-values. Starting with Debt-capital ratio, it is observed that coefficient is -31.981, this means that, between change in investment and debt-capital ratio, there exists an inverse relationship. To put in perspectives, when there is an increase in the increase in debt-capital ratio by 1 unit, there is decrease of investments by 32 units. In terms of standardized coefficients, an increase of 1 standard deviations will cause the investments to decrease by 0.639 unit of standard deviation.

Further, it is important to note that, the p-value of the debt-capital ratio is 0.009 which is very much within the 0.05 threshold limit. Thus, it evidences the hypothesis that, there is a negative causal relationship between the investment in fixed assets and debt-capital ratio/ leverage of the firm. This complies with Mills et al (2001) and Liu and Pang (2009) which evidences the role of leverage in making investment decision. In fact, Liu ang Pang (2009) went one step more to suggest that, not only does the leverage affect the investment but also the debt-overhang problem, i.e. the impact of past borrowing affects the future investment decisions. In this study, the debt-capital ratio is lagged by one period in order to capture the effect of debt overhang as suggested by the existing literature.

Secondly, industry-average Tobin's Q shows that, the relationship with the investment in fixed assets is positive and this complies with the theory proposed in Tobin (1969) that higher Tobin's Q translates into higher investment. However, the beta is 0.43 implying that, the magnitude is weak and that, for a change in Tobin's Q of 1 unit, the investment changes by only 0.43 units. However, the important aspect is that, this relationship is not statistically significant. The p-value of this pair of relationship is 0.455 which exceeds the p-value threshold limit of 0.05. Thus, in other words, the relationship of this pair of variables has a high probability of being random. While this may sound as a defect in the model, it should be noted that, this result perfectly matches the evidence in the literature. Bernanke et al (1993) found evidence that the fundamental Q is more correlated with investment decisions and that, the Tobin's Q is very weakly correlated with investments. Bernanke et al (1993) went on to say that investment decisions are not a dependent of Tobin's Q and that, the management should not be influenced by the market value of the firm. Further, in specific to Technology sectors, it is known technology stocks are subject to high volatility and variability since these companies are high growth companies. Therefore, the fluctuations of these stock may be due to the demand and supply forces and the market. Moreover, from Graph (2), we know that there is a widening gap between the change in fixed investments and the change in R&D expenses, therefore, the reason why there is a breakdown of this pair of variables could be that, in response to the change in Tobin's Q (assuming that there is a statistically significant relationship between investments and

Tobin's Q) the companies might allocate their funds heavily towards R&D of intangible assets.

Going over to the third variable, R&D expenses, the relationship of this pair of variables is very interesting. This is because, contrary to the hypothesis, the investment in fixed assets and R&D expenses go hand in hand, that is they are directly correlated. This comes as a surprise as the hypothesis was that, since the companies in technology sector does not engage in heavy manufacturing, the bulk of the resources go into development of intangibles which, in other words means that, there should be an inverse relationship. However, the ratio between R&D expenses and fixed investment is 1: 14, which means that for every unit of increase in R&D expenses, there is 14 times the amount invested in fixed assets. Also, this cannot be disregarded as spurious results as the p-value is 0.004 at 5% confidence interval. Therefore, there exists a causal relationship between the fixed investment and the R&D expenses. The reason for this relationship can be due to a number of factors. Firstly, these sample companies are huge multi-national corporations, that being the case, they are the companies pioneering in new innovation and technology. Although it nature of products of most of these companies are software and technology services, they store a huge amount of data that needs datacentres. Having said that, most of these companies have global presence and this relationship could reflect upon the FDI of these companies abroad also. Further, the R&D expenses need not always be improvement of a process or a software, it could also be an upgradation of storing data with needs heavy fixed investment in building datacentres. Moreover, it can also be argued that R&D expenses can partially be the viability testing of a fixed investment proposed for the future. Lastly, companies in technology sectors are conducting R&D in pioneering fields which requires heavy foundation investments that will yield benefits in the future.

Lastly, the pair between cashflows and fixed investment is rather unsurprisingly, unlike the previous variable. The result shows that, for every one-unit increase/decrease in cashflows, the fixed investment changes in the same direction by 1.159. however, this is not the one that is unsurprising, but the fact that, the p-value is 0.739 where the threshold limit is at 0.05. This again shows that, the companies in technology sector are least affected by the problem of liquidity. For instance, earlier this year, according to an article on CNBC news

website, Apple Inc. (one of the companies in the sample) announced that it will repatriate it 'cash hoard' of $285Bn back to America. For such companies, liquidity is not a primary determinant of investment decisions. Most of the companies in the study's sample are huge global technology giants, therefore the problem cash crunch and liquidity crisis cease to exist.

Therefore, through this analysis, we found evidence that, out of 4 determining variables used in the model, only two was statistically significant, them being Debt-Capital ratio and the R&D expenses. However, it is also important to note the R-Squared of the model, which is close to 43% or 0.439. This means that, the changes in dependent variable is explained by corresponding changes in independent variables up to 43%. This is having moderate predictive power; therefore, it will be useful to extend the model to include the macro-economic variables. The tables below show the extended version of the investment model having omitted the internal determinants which are not significant.

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Change in GDP per capita rate, Interest rate, Debt-Captal (t-1), R&D Expenses (Log)[b]	.	Enter

a. Dependent Variable: Investment (% change)

b. All requested variables entered.

Table (10)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.649[a]	0.421	0.380	2.35394	0.421	10.198	4	56	0.000	1.382

a. Predictors: (Constant), Change in GDP per capita rate, Interest rate, Debt-Captal (t-1), R&D Expenses (Log)

Dependent Variable: Investment (% change)
Table (11)

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	226.027	4	56.507	10.198	.000[b]
	Residual	310.298	56	5.541		
	Total	536.325	60			

a. Dependent Variable: Investment (% change)

Predictors: (Constant), Change in GDP per capita rate, Interest rate, Debt-Captal (t-1), R&D

Expenses (Log)

Table (12)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound
1	(Constant)	-29.475	12.145		-2.427	0.018	-53.805	-5.145
	Debt-Captal (t-1)	-18.613	18.232	-0.398	-1.021	0.312	-55.137	17.910
	R&D Expenses (Log)	11.563	5.243	0.897	2.205	0.032	1.060	22.067
	Interest rate	-0.517	0.838	-0.118	-0.617	0.539	-2.197	1.162
	Change in GDP per capita rate	0.088	0.511	0.018	0.173	0.863	-0.935	1.112

a. Dependent Variable: Investment (% change)

Table (13)

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-2.2544	5.8324	3.5713	1.94090	61
Std. Predicted Value	-3.002	1.165	.000	1.000	61
Standard Error of Predicted Value	.350	1.472	.635	.229	61
Adjusted Predicted Value	-2.8071	6.3865	3.5864	2.00027	61
Residual	-5.96537	5.65016	.00000	2.27412	61
Std. Residual	-2.534	2.400	.000	.966	61
Stud. Residual	-2.701	2.530	-.002	1.022	61
Deleted Residual	-7.07750	6.27844	-.01512	2.56435	61
Stud. Deleted Residual	-2.870	2.664	-.002	1.047	61
Mahal. Distance	.345	22.489	3.934	3.980	61
Cook's Distance	.000	.707	.028	.095	61
Centered Leverage Value	.006	.375	.066	.066	61

a. Dependent Variable: Investment (% change)

Table (14)

The results of this extended model are very interesting. When the coefficients are observed, the leverage remains the dominant factor with -18.613 as the coefficient and R&D expenses remaining the second most dominant factor at 11.56 as the coefficient. However, the macro-economic variables evidence a weak relationship with the firm level change in fixed investment. The change in GDP per capita has a beta of 0.088, which means that with every one unit of GDP per capita change, there is only 0.088 unit of corresponding change in investment. Likewise, despite the negative influence the interest rates have on the fixed investment, it is affected only by 0.517. But, the most important aspect is that, only R&D expenses is statistically significant in the model. It follows that, despite the distortions by the macro-economic variables, the relationship between the R&D expenses and fixed investments remains steadfast at a p-value of 0.032 which is less than the 0.05 limit. As discussed in the previous model, these companies are well established MNCs which due to their size and scale of operations have economies of scale. In the existing literature, Mills et al (2001) observes that as a company ages and grows in size, the need for conventional fixed asset investment declines and the investment expanding the product lines takes precedence. Thus, as most of the companies in the sample are a minimum of 20 years, the fixed investment, i.e. in plant and machinery or building decreases substantially. Further, as mentioned earlier, the companies in the technology sector are all cash-rich and do not face liquidity crunch. This is why there is no causal relationship between interest rates and fixed investment as the companies are, most of the times, self-sufficient by ploughing back the profits and retained earnings. It should be noted that, despite the breakdown of relationship among other variables in terms of p-value, the relationship between R&D expenses and fixed investment remains to be a causal relationship. This shows that R&D expenses is one of the most important determinants for investments in the US technology sector.

In conclusion, the determining factors that affect the fixed investments are the leverage of the company and R&D expenses. It is observed that, the macro-economic scenario does not impact the investment decisions of technology companies which is reasonable to expect considering the lack of liquidity problem in the sector.

Having said that, this study has considered only the top biggest companies in the sectors and it acknowledges the possibility that liquidity might play a very important role in investment decisions at the firm level. Regarding the R&D expenses, the analysis refuted the hypothesis that, the relationship with investments will be negatively correlated. The analysis rendered a positive coefficient proving that the relationship between the two pairs is actually positive and that they move in the same direction.
The finding of the study can be spilt in two, the first being, that R&D expenses and the leverage play an important determining factor in influence investment in fixed assets and the second being, there is no significant effect of GDP per capita and interest rates on investment decisions of the technology firms.

6(d). Conclusion

Now that we have gone through the analyses and empirical results, we have a fair idea of what factors affect the fixed investment in the US technology sector. First, there is clearly evidence of increase in R&D expenses compared to fixed investment, however, the regression results show that, the relationship between the fixed investment and R&D expenses is that of positive, meaning that when one increases, the other also increases. This can be because of the research in new pioneering fields which needs high initial investment. Further, the relationship of leverage of a firm with its investment decision is also strong as the literature suggests. In fact, in terms of beta, leverage weighs on the investment decisions heavily. This study showed that, there is a negative relationship which means that, when the debt increases, the rate of investments decreases.

It should noted be noted that, the GDP per capita is very weakly related with investment decisions. This is seen in both the correlation matrix and the regression results. The reason for this may be due to the fact that, most of these companies run a different kind of business model which is, to some extent immune to seasonality of the economy. For instance, Google's business model is data-centred, meaning that they generate revenue by selling data. And, companies like Oracle and Amazon generates the bulk of their revenue by managing third-party data in cloud servers. Thus, these companies do not engage themselves in selling any physical products which may be subject to seasonal fluctuations. Thus, it can be concluded that, in doing the analyses, it

was evidenced that, the two determining factors are R&D expenses and leverage of the firm.

2. Conclusion

The overall objective of this research was to determine the variables or the factors which the fixed investment in the technology sectors of US. For this purpose, a sample of 16 companies were taken for analysis. The conclusion that is drawn by this analysis can be categorized into four main findings:

a. Leverage as a significant determinant of investment: Through the regression results, it was observed that, the debt-capital ratio provided a statistically significant measure of beta in relation to the investment function. This revealed that, the leverage of the firm impacts the investment decisions of the firm. It should be noted that, since the beta of debt-capital ratio is -31.12, it means that, the leverage of the firm has a significantly huge impact on investment decisions. It complies with Liu and Pang (2009) which stated that debt of a company is an important determining factor.
b. Cashflows not a significant factor: This did not come as a surprise. It was observed that, cashflows did not have a significant beta nor did it possess a significant p-value, thus evidencing that, for technology companies, cashflow is not a determinant of investment. This fits with the information that most companies in technology are self-sufficient cash-rich companies with no liquidity crunch. In this aspect, the results of this study differs with the works of authors like Mills et al (2001) and Das and Tulin (2017).
c. Lack of significant impact of macro-economic variables: In the modified regression model which included the interest rates and GDP per capita, it was observed that, the beta of GDP per capita was negligibly low, 0.088. This was coupled with insignificant p-value which clear gave an indication that the GDP per capita is not a determinant of investment behaviour in the technology sector. To further confirm this, the interest rate also possessed an insignificant p-value thereby clearly evidencing that the investment behaviour is not affect by macro-economic scenarios. This is further proven when the R-Squared of the modified regression remains the same as when only the internal factors are included, at 0.423.
d. The R&D-Fixed Investment Paradox: This is the most interesting and puzzling conclusion of the analysis. Back in sub-section 6(b), when the study showed the rationale for selecting R&D expenses as a dependent variable, it rationalized that, due the widening gap between change in fixed investment and change in R&D expenses, the study concluded that, the financial resources are being utilized more for R&D expenses and significantly lower for fixed investment by interpreting Graph (2). However, the regression

result produced a beta of 14.61, meaning that, for every one unit increase in R&D expenses there is a corresponding 14.61 units increase in fixed assets. This is very puzzling as; both the interpretations are derived from empirical analysis but are rendering quite opposite results. Although, this paper attempts to give probable reasons for this paradox, it is not empirically supported and are just possibilities.

Therefore, one major finding is that, there exists an inexplicable paradox between R&D expenses and fixed investment that this research has acknowledged that, it needs further research and analysis to resolve the paradox.

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Investment (% change)	Debt-Captal (t-1)	Industry average Tobin's Q (t-1)	R&D Expenses (Log)	Log CF (t-1)	Interest rate	Change in GDP
5.807010928	0.517575604	3.777486667	3.90855653	3.595217299	1.68	0.379790049
8.239096408	0.507501141	3.428566667	3.890335869	3.507802905	1.3225	0.191660633
5.012049624	0.476062092	3.20066	3.87201571	3.351136274	1.1525	-0.089521698
10.06840751	0.474801537	2.911186667	3.855141432	3.347656358	0.91	0.344109775
7.174632539	0.47429632	2.767326667	3.836523525	3.571308708	0.565	0.633205285
5.236839356	0.4861822	2.44618	3.818751648	3.494855589	0.3975	1.425212742
4.893794585	0.479066818	2.608966667	3.803389212	3.365074963	0.3775	0.898987608
4.87444021	0.474248225	2.394253333	3.792061958	3.308648037	0.33	0.337011693
5.992044656	0.473545733	2.337353333	3.780318709	3.544000072	0.13	0.539579373
4.425910657	0.469989369	2.5202	3.767401352	3.389840534	0.125	0.690117117
3.118415263	0.46544598	2.361406667	3.753861357	3.3689864	0.1125	0.745411689
1.944411432	0.447551237	2.259126667	3.740676889	3.353696445	0.09	0.886563767
3.643720896	0.445885537	2.064606667	3.726603818	3.562859056	0.0925	0.245000398
5.296443448	0.436447701	1.979035714	3.712646638	3.363284385	0.0775	0.631395602
1.801402857	0.425970408	2.117257143	3.696965744	3.333154443	0.085	0.378586217
6.185190864	0.416467273	2.10605	3.671945317	3.273254233	0.0925	1.096007957
7.368455069	0.42219368	2.022164286	3.65655031	3.453772802	0.145	0.00780016
3.906398332	0.396535403	1.996392857	3.639057701	3.324552609	0.155	-0.103459046
3.508324417	0.377558858	1.85425	3.623038296	3.226039681	0.1525	0.589924707
4.293308874	0.369636242	1.767178571	3.612214749	3.274268459	0.1125	0.015521925
5.189606971	0.390820744	1.685121429	3.5978105	3.438247775	0.075	0.346101046
2.192067803	0.3925759	1.561764286	3.587130441	3.262543101	0.075	0.283422666
4.089545556	0.374230231	1.703321429	3.57222171	3.23461335	0.0875	0.351591769
10.48507907	0.359354566	1.707578571	3.558108045	3.270150638	0.1425	-0.797877491
5.402724819	0.379342274	1.790542857	3.537946125	3.403149842	0.105	0.295423827
5.829602699	0.377519642	1.637278571	3.515098952	3.29472101	0.175	-0.790129223
-0.691013362	0.379297269	1.815921429	3.497599393	3.235643807	0.1425	-2.452446465
6.449016771	0.365737393	2.477657143	3.505937237	3.174017118	0.1875	-1.33963751
5.746412634	0.37757901	2.746153846	3.487764418	3.242735559	0.175	-0.350784703
9.120999366	0.368546541	2.415653846	3.470707966	3.195537774	0.1875	0.133646525
6.607577196	0.357161336	2.364961538	3.452788158	3.124158412	0.1875	0.857240369
3.103716247	0.35304524	2.309838462	3.434877932	3.109306524	0.1875	0.184357654
1.489783089	0.346351526	2.384338462	3.416645773	3.194435264	0.1875	0.732032384
2.839846686	0.332133477	2.204723077	3.399885713	3.163063707	0.185	0.532251682
0.0210223	0.338671402	2.216123077	3.404091336	2.986982085	0.1875	0.297883253
0.486729511	0.329652941	2.008423077	3.400363612	2.934654635	0.15	-0.408041993
1.63014876	0.325512241	1.6877	3.407496396	3.135863814	0.185	0.541765169
1.456593027	0.344306441	1.666530769	3.411796534	3.066481399	0.12	-0.229049838
2.805169294	0.331040114	2.629384615	3.411861673	2.942965456	0.15	0.952455458
5.03491618	0.328469197	2.794046154	3.404741692	3.004675659	0.1275	0.612292501
4.957828539	0.317886023	3.058838462	3.366187761	3.057121081	0.12	0.263657865
3.086644958	0.317078203	3.426523077	3.344922326	3.09418332	0.1475	-0.062075655
2.142547658	0.30998759	3.538361538	3.322885691	2.935898928	0.1275	-0.081540732
2.482403293	0.30799471	3.252953846	3.304419971	2.947967096	0.1775	0.728520217
4.347579411	0.306582853	2.982061538	3.289406148	2.878183611	0.1475	-0.034703478
1.025082523	0.303034528	3.067676923	3.279494404	2.919350444	0.18	0.580782427
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4.964467972	0.306432451	3.015546154	3.276151908	2.788843431	0.175	-0.420964008
6.90445686	0.294935116	3.323984615	3.257994777	2.7710306	0.18	1.06767629
3.191697402	0.280927921	3.657715385	3.233109153	2.92292414	0.23	0.991490797
2.787372998	0.293083757	3.587861538	3.208780238	2.844835357	0.175	0.265440407
2.444413355	0.306098989	3.320184615	3.1880587	2.878017775	0.8325	0.655536779
3.213335288	0.316028271	3.249492308	3.172542691	2.886318947	0.23	0.649434512
1.370713888	0.29674812	3.542653846	3.162797643	2.863618139	1.6975	0.038729667
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0.29693533	0.375272877	3.940538462	3.123195685	2.646737807	2.2175	0.571831852