Analysis of the Impact of Capital Structure in the Innovation of a Firm Using the Techniques of Financial Engineering

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Abstract

One of the crucial aspects for a firm is to choose the right mixture of debt and equity to make a financial decision. While debt is a cheaper source of equity as it offers tax savings, there are other financial risks associated with the use of debt such as high-interest rates and cash flow difficulty. Equity is less risky, but more expensive when compared to debt financing. It might take several years to gain returns from an innovative project, and all companies do not have enough internal resources to invest in research and development which is one of the main reasons companies seek external financing sources. In this paper, the use of debt/equity and its impacts on the innovative activities of a firm will be discussed. A rigorous study of the impact of leverage on the research and development expenses of a firm (a proxy of innovation) will be conducted with the help of Regression analysis to show that debt financing of a company is not directly related to the innovation output of a firm when the market value of firms are controlled. This study explores meaningful insights on how capital structure affects the technological innovation of a company.

Keywords
Capital Structure, Debt and Equity, Innovation, Financial Leverage, Research and Development

1. Introduction
Capital Structure is one of the decisions alongside investment and dividend policies a company must take to optimize the value of the firm. A capital structure of a firm is a topic which is affected by asymmetric information. In corporate financing, asymmetric information is a condition when the internal people for instance, managers have a better information of their firm's value and investment opportunities when compared to the market participants (Klein et al. 2002). A capital structure decision can be really complicated to take considering the costs and benefits associated with debt and equity securities. Any wrong capital structure decision might lead a firm to financial distress or bankruptcy (Seetanah et al. 2014). To compensate this challenge, this paper focuses on the kind of impact that capital structure of a company has on the research and development of a firm. This paper further explores the relationship between different variables related to financial analysis of capital structure of a firm.

Companies primarily use debt and equity financing to raise capitals for their business, but both have their own upside and downside. Mostly, companies use a mixture of debt and equity depending on what a company needs during different circumstances. Debt financing involves borrowing money where there is an obligation to pay it back with interest in the future. One of the major advantages of debt financing is that a company does not have to give ownership of the business to someone else, and there are several tax benefits. On the other hand, Equity is riskier and more

expensive when compared to debt financing, but the company does not have the obligation to pay the money back. One of the downsides of Equity Financing is that the company must give a part of its ownership to the investor who is helping to raise the capital. There has always been an argumentative matter among financial analysts and experts on whether there is an optimal way to finance research and development or not. If there is any possibility to get the perfect mix to finance research and development, would it be done in a conventional way or would it be financed with one mix of securities against the other? An organization would likely manipulate the market value of its shares through its financing policy if it were to finance by raising equity (Syed and Abdur 2013). In another study, Blass and Yosha (2003) reported that the research and development intensive firms based in the US stock exchange prefer to use equity-based financing while those firms listed on Israel rely more on bank financing and governmental funding (Chen and Zhang 2019). According to Hovakimian et al. (2001), "Traditional corporate finance models suggest that firms select optimal capital structures by trading off various tax and incentive benefits of debt financing against distress costs. While there is support for these tradeoff models in the empirical literature, recent evidence suggests that a firm's history may play a more important role in determining its capital structure." Managers prefer to fund new investments and research activities with retained earnings instead of debt, but managers prefer debt over equity financing. On a contrary, while debt is a significant source for corporate investments, it isn't considered favorable for innovation investment (Chen and Zhang 2019). Several firms tend to issue shares when they see an increase in the price of their stocks. The pecking order model suggests that firms repurchase their equity when they see that their value has increased (Hovakimianet et al. 2001). The pecking order model affects the corporate debt ratio in the short run, which makes the firms take financial decisions which move them towards target debt ratios that are consistent with the trade-off models of capital structure. The firms which are more profitable tend to have lower leverage ratios, but another finding suggests that more profitable firms are more likely to issue debt rather than equity and it is highly likely that the profitable firms purchase equities rather than retire debt. According to the pecking order theory which was proposed by Myers and Majluf (1984), firms' preferred option is to finance research and development activities with internal resources when the firm is profitable and adequate amount of retained earnings is available. When adequate internal resources are not available for sponsoring an innovative project, firms tend to prefer debt financing instead of equity financing. Equity financing is the last option for a firm to go to when it comes to financing research and development projects (Bartoloni 2011). The companies which are more profitable are under-levered and the firm's financial decisions are most likely to offset the earning driven changes in their capital structures. Another interesting finding by Hovakimian et al. (2001), suggests that the firms that have high stock prices which are relative to book values or earnings like to issue equity rather than debt and purchase debt rather than equity. These findings were mostly true and remain consistent where the financial experts tend to issue equity at lower prices to boost their leverage when their stock prices are low (Hovakimian et al. 2001).

Early empirical studies stated that because of the tax shield benefits of debt, managers choose debt financing over equity financing. Various kinds of debt-to-equity ratios are taken account to test whether non-debt tax shields like investment and amortization tax credits substitute for debt tax shield. Several findings later have proved that the use of debt is directly related to higher marginal tax rates. The fundamental theory of capital structure is the tradeoff model which contradicts the observed empirical evidences. The tradeoff theory is also often referred as the static trade-off theory which states that the leverage of a firm should be directly related to profitability because firms can directly profit off the tax shield of increased leverage. Nevertheless, empirical studies show that the observed relationship between profitability and leverage is negative. On the other hand, the effects of innovation remain ambiguous, and some studies even suggest that research and development efforts are negatively related to leverage (Koslowsky 2009).

It might take several years for a company to produce economic gains from an innovative project and several companies do not have the financial ability to cover the cost of the project with the internal resources. In an imperfect world with asymmetric information, bankruptcy, and agency risks, financing an innovative project externally can be costly. There has been a speculation that the financial constraints affect the innovation investments more severely because the level of uncertainty related with innovation output is high (Bartoloni 2013). With the increase in firm's operating profitability, the firms are less indebted and the use of external financing increases with their innovative effort. According to Bartoloni (2011), "The need for external finance increases with the innovative effort as shown by the fact that in all the econometric specifications, both static and dynamic, a positive relationship is found between alternative proxies for innovation intensity based on measures of both innovative input (the share of intangible assets to total assets) and innovative output (the share of a firm's sales due to the introduction of a product innovation). This relationship holds regardless of a firm's size."

Most of the empirical research on the relationship between a firm's funding and innovation assumes that causality flows from finance to innovation. However, there is reason to think there might be a reverse casualty where creative ventures and innovations open new markets, which might create unique changes in the financial structure decisions. There has been a support for this reverse causation hypothesis that innovative projects cause financial decisions and change in the financial structure in both the country and sectoral level (Hirukawa and Ueda 2009).

This paper can provide support to the entrepreneurs who are seeking information regarding the impact of debt financing and equity financing on innovation of a company. Similarly, it can provide information to researchers regarding how market value of a company influences the innovation capacity of a firm with the help of regression analysis.

2. Related Literature

There are several literatures which have previously reviewed about the financial leverage and innovation of a company. This paper will be focusing on some of the important literatures which has helped in the research of this paper.

The economic obstacles are more likely to be seen in smaller firms rather than big firms, and the firms are more likely to use debt financing instead of equity financing to finance the research and development of projects. Credit accessibility does not play a role in determining the capital structure of large firms which means that the large firms have preferential access to bank loans because of higher reputation compared to smaller firms and this enables the larger firms to undertake huge innovation efforts. Likewise, capital structure of large firms is not directly related to the increase in operating profitability where the success of these large firms are linked with the preferential relationship, they have with banking firms (Bartoloni 2011). It can be argued that smaller firms find it difficult to finance innovation through debt or equity and rather use short-term loans which appear to be less costly for them to invest in research and development.

According to Marinescu et al. (2004), the higher innovative firms tend to have more bankruptcy costs since they have higher proportion of intangible costs, such as knowledge and reputation. The bankruptcy risks can be decreased by these innovative firms by reducing their dependency on debt financing. However, for the innovative firms, there will be higher degree of asymmetric information and dilution costs will be higher. Equity financing can be more expensive compared to debt financing for these firms, but they will be able to attract more investment opportunities than less innovative firms. Therefore, more innovative firms are expected to rely more on debt or equity than less innovative firms who have the tendency to finance their research and development with their internal resources.

According to Bradley et al. (1984), optimal capital structure focuses on creating a balance between the tax advantages of debt and the bankruptcy costs associated with using debt. They focused on a new challenge stating that under certain conditions, the tax disadvantages of debt financing at a personal level is balanced by the tax advantages of debt financing at a firm level. There are various leverage costs associated with using debt financing such as bankruptcy costs, agency costs, and loss of non-debt tax shields which offset the tax advantages of debt financing.

One of the findings by Zhang et al. (2019) states that equity financing can be better compared to debt financing in terms of innovation. The main reason to support this hypothesis is that equity financing is more tolerant to uncertainty, and it enhances a company's risk preference for technological innovation. Their results show that there is negative correlation between debt financing and technological innovation, and a positive correlation between equity financing and technological innovation. According to the findings by Chen and Zhang (2019), debt is a disfavored source of financing for research and development. The spending on research and development decreases with the use of debt over the time which is similar to the findings from this paper.

Research and development intensive firms that were leveraged suffer more from economic crisis when compared to other firms as the cash flow is highly reduced during economic distress. Similarly, sunk costs associated with research and development investments are higher than those for ordinary investment. Managers are considered to be more risk averse than shareholders and avoid innovative activities that will increase the riskiness of the firm. In the risk of bankruptcy, managers whose opportunity costs is lower are likely to avoid variance increasing projects which shareholders are likely to undertake (Hall 2002).

The results from Zhang et al. (2019) also supports the findings of Hall (2002). When market value of firms is controlled, the regression analysis helps to provide a negative relationship between debt financing and innovation. As a result, equity financing has a positive relationship with technological innovation. The insights drawn from the regression analysis conducted in this paper, it can be stated that the use of equity financing by firms leads to increase in the research and developmental activities of a firm even though equity is considered to be an expensive source of leverage when compared to debt. Even though debt has a lot of tax advantages, equity financing will help to attract more investing opportunities which in turn help to facilitate research and developmental activities.

3. Methods and Data Collection
The focus will be on debt and advertising expenses while collecting the data from a wide variety of different companies over the course of two years in that deal with innovation. The data was collected on March 1, 2020 (Sokolov, 2020). Debt, and research and development expenses of 12,502 different observations will be considered from different companies of the United States in the year 2019 and 2020 (Sokolov, 2020). These data will be used to show the relationship between debt and innovation. Companies with less than a million worth of total assets to companies with up to nearly 4 trillion worth of total assets were analyzed (Sokolov, 2020).

The data was obtained by collected 12,502 different companies on the NASDAQ index. These companies were all based on innovation and technology. To select the different companies the parameters were set as the following:
1. Be listed in NASDAQ.
2. Date from March 1, 2019, to 2020.
3. Priced from $0 to $1,000.
4. Still operating on NASDAQ at the end of 2020.
5. Automatically select 12,502 companies.

Regression analysis will be applied to establish the relationship of the use of debt and equity on innovation. The strength and relationship of debt with innovation will be determined and interpreted with the help of regression analysis. This paper will stress on establishing the relationship with the use of debt and equity on innovation where the market value of all firms will be considered equal.

4. Results and Discussion
The two different scenarios of the research findings are explained below.

4.1 The Results of The Regression Analysis Without Controlling the Market Value of Firms
Since, the beta coefficient is positive (As Table 1 shows), we can say that the relationship between the use of debt and innovation is positive when the market value of firms are not controlled. With every increase in debt financing, innovative activities increase. In other words, it can be said that research and developmental activities of the firms in the US increase with the use in debt financing. With every 1 million dollars increase in debt financing, innovation activities increase by 0.3947868 million dollars. Since, debt = 1 – equity, it can also be said that equity financing will have a negative relationship with innovation when market value of firms is kept the same for all firms. The relationship between debt and innovation is also highly significant as the p-value < .05 for 95% confidence interval.

Table 1. Regression Analysis Without Controlling Market value of firms.

Source	SS	df	MS			
				Number of obs	=	12,502
				F(1, 12500)	=	13.59
Model	12349427.3	1	12349427.3	Prob > F	=	0.0002
Residual	1.1356e+10	12,500	908518.967	R-squared	=	0.0011
				Adj R-squared	=	0.0010
Total	1.1369e+10	12,501	909434.166	Root MSE	=	953.16

xrd	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
debtinthousand	.3947868	.1070795	3.69	0.000	.1848946	.604679
_cons	104.6097	8.546106	12.24	0.000	87.85803	121.3614

4.2 The Results of Regression Analysis with Controlling the Market Value of Firms

When controlling the market value of the firms, it can be interpreted that there is a negative relationship between debt financing and innovation since the beta coefficient is negative. It can be said that with every million dollars increase in debt financing, innovative activities decrease by 0.3158936 million dollars (As Table 2 shows). Since the relationship between debt and innovation is negative, it can be said that the relationship between equity financing and innovation is positive. The relationship between debt financing and technological innovation is highly significant as the p-value is 0.000 which is less than significance level of 0.05.

Table 2. Regression Analysis with Controlling Market Value of Firms.

Source	SS	df	MS			
				Number of obs	=	10,719
				F(2, 10716)	=	6424.25
Model	5.1387e+09	2	2.5693e+09	Prob > F	=	0.0000
Residual	4.2858e+09	10,716	399942.82	R-squared	=	0.5452
				Adj R-squared	=	0.5452
Total	9.4245e+09	10,718	879311.108	Root MSE	=	632.41

xrd	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
debtinthousand	-.3158936	.0763123	-4.14	0.000	-.46548	-.1663073
mkvalt	.015014	.0001326	113.26	0.000	.0147541	.0152738
_cons	-29.37325	6.205484	-4.73	0.000	-41.53714	-17.20935

4.3 Proposed Improvements

The regression analysis used in finding the impact of financial leverage on innovative activities might not be sufficient to prove that research and development of a company truly depends on equity-based financing or debt financing. Several other financial engineering techniques might be required to demonstrate that research and development of a firm depends on financial leverage of a company. Similarly, the firms which were analyzed with the help of financial engineering techniques is geographically limited to the United State of America, and the results obtained might not be applicable to other regions of the world. The market value of the firms while doing the regression analysis was controlled, and there might be several other factors which needed to be controlled to get a true representation of the impact of leverage on the innovative activities of the firms.

5. Conclusion

Using different financing sources have their own pros and cons. While it is cheaper to use debt because of its tax benefits, it can be a concern to the firm because of high interest rate and cash flow difficulties. While there is no risk to pay back loan on equity financing, it can be highly expensive at the same time. It is important to find the right mix

when it comes to investing on research and development as innovation can backfire the cashflow of a company and the ability to pay back to the respective sources.

One of the major findings from the regression analysis of 6,251 firms from the US in 2019 and 2020 reveals that the debt of a company has a negative relationship with research and development when the market value of companies are controlled. The investment on technological innovation decreases with the use of debt financing over the period, and it can be said that equity financing is a better choice when it comes to investing on research and development. While there can be loss of ownership or control, equity financing is less risky to uncertainties like a global pandemic or economic distress as there is no obligation to pay back the loan or interest rates. Also, several bankruptcy costs can be reduced by reducing the use of equity financing. These findings have been highly significant as the p-value is 0.000 which is highly precise.

There was another major finding from the regression analysis shows that when the market values of firms were not controlled. There is a positive relationship between debt financing and innovative activities when the market value of firms are not controlled. This implies that firms with higher market value do not have a problem financing research and development with debt financing as they have enough internal resources to pay back the loan on time and not lose their credit worthiness.

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Biographies

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