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R&D Intensity and Market Valuation of Firm

A Study of R&D Incurring Manufacturing Firms in India

Pramod Kumar Naik

ABSTRACT

This study examines the impact of R&D expenditure on market valuation of firm proxied by Tobin's q using firm level data for manufacturing firms in India. To accomplish the research objective this study obtained data from Prowess database of Centre for Monitoring Indian Economy (CMIE) over the period of 2001-2010. The study forms an unbalanced panel comprising 2382 firm-year observations and employs Pooled-OLS and fixed effects models to analyze the relationship between R&D intensity and firm value as measured by Tobin's q. The findings reflect an inverted U-shaped relationship between R&D intensity and firm value indicating the diminishing marginal return to each unit spent on R&D. The result implies that R&D investment have a positive impact on the market value of firm at the beginning, however, after a point these investments lower the market performance of firms.

***Key Words**: R&D intensity, Firm value, Tobin's q, Manufacturing firms.*
***JEL Codes**: O32, L25, E44, O14.*

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INTRODUCTION:

It is widely acknowledged that innovative firms can maintain an advantage in a competitive market by minimizing their production costs through their active research and development (R&D) practice enabling them to maintain larger market share and gain higher profits (Xu and Zhang, 2004). R&D activity helps to develop firm's capability, enhancing its ability to learn new technologies and to match technological possibilities which sustain its market position. It also creates new technologies, products, and solutions designed to satisfy customer needs that are not easily imitated by competitors and hence gain competitive advantages. This behavior of a firm enables it to differentiate itself from other firms (Ho *et al*., 2005). Perhaps this motivates firms to focus more on innovation activity to survive the global competitive markets and thereby the firm value.

Stock market can provide useful information on the firm's market value and the expected performance of firms R&D investment. It is argued in the literature that this investment creates value for firms by generating some intangible assets (Griliches, 1981; Connolly and Hirschey, 1988). However, questions may arise that whether more investment in these activities are always better? Unlike other investments, the investment on R&D may take long time to get their reward and may even go waste if there is a failure. Thus, the R&D expenditure of any firm has a potential reward and also a great uncertainty in the future return on it. The firm which engage and spend more on R&D is liable to accept higher risk and if success a higher profit. It can be argued that the uncertainty of the results of R&D may

also lead to higher volatility in firm value with the increasing information asymmetries in the market. Consequently, it is bit difficult to predict how investment on such activities will impact on firm's market performance and the R&D efforts are needed to be carefully managed and investigated

During the early 1990s the Indian policy makers acknowledged that improved performance and efficiency is supposed to be a prerequisite for growth. The liberalization policy created a technological paradigm shift in various forms which encouraged competition in a number of ways like increased import and entry of new firms etc. (Narayanan and Banerjee, 2004). As Bhat and Narayanan (2009) noted, firms are now putting in particular efforts to acquire technological capabilities through investments in various sources of technology such as in-house R&D, import of capital goods, import of designs, drawings and blueprints, and import of raw materials. Given the newly industrialized and globalized economy and the increasing emphasis on the technology and in-house R&D in a developing country like India, whether the R&D activities of firms significantly affect the firm valuation[i] remains an empirical question. So far most of the studies in this issue have concentrated on developed countries such as US and Japan and the studies from developing countries are in its nascent stage. Scant systematic studies are concentrated on this issue. There is a need to study the impacts of R&D investment on firm's market performances in India as well since the adoption of reforms open the economy and increased the competition among firms wherein more and more firms are increasingly involved in in-house R&D.

The basic objective of the present study is to examine the impact of R&D expenditure on firm performance using a financial market-based measure Tobin's q for R&D incurring manufacturing firms. An investigation of firms those involved in R&D is expected to provide more in-depth idea of the stock market performance in an emerging economy. In addition, the present study tries to examine whether the R&D investment exhibits the diminishing marginal returns. To do so a squared term of R&D intensity is used as an independent variable to check the potential nonlinear relationship between R&D spending and stock market performance of firm. The analysis has been done by controlling a number of firm specific variables viz. firm sizes, age of the firm, advertisement intensity, intensity of technology imports , export intensity, profit margin and financial leverage. The results show a significant non linear relationship between R&D intensity and firm value.

The rest of the paper is organized as follows. Section 2 discusses the review of some empirical literature. The empirical model specification is given in section 3. In section 4 discusses about the data sources, sample, and econometric methodology used in the study. The empirical findings are presented and discussed in section 5 and finally section 6 concludes the paper.

2. REVIEW OF LITERATURE

From the last few decades an increasing number of research scholar have become more interested in measuring the impact of R&D investment on market value of firms. Some studies have analyzed the relationship between the R&D investment and market value, whereas, some other studies examined how different R&D based measures explain the firm's long-run and short-run stock returns. Most studies used Tobin's q ratio as a proxy for firm value and examined the relationship between R&D expenditure and firm's market performance. Some notable empirical literatures in this context are discussed below.

Griliches (1981) constructed the Tobin's q measure to examine the impact of R&D on firm value using a sample of 157 firms from US for the period of 1968 to 1974 and documented a positive and significant relationship between R&D intensity and Tobin's q. Hirschey (1982) modelled advertising and R&D expenditures using a market valuation approach and obtained positive coefficient for both advertisement and R&D expenditure. Connolly and Hirschey (1988) included R&D expenditure, patents and advertisement expenditure as the measure of intangible assets to firm and analyzed for a sample of 390 US firms that engaged in private sector R&D for the year 1972 to 1977. Their estimation results indicated a positive relationship between the market value of firm and the mentioned intangibles. Chauvin and Hirschey (1993) examined the impact of R&D expenditure and advertisement to the firm market value based on the Tobin's q model. They divided the total sample as manufacturing firms and non-manufacturing firms. Their estimated results revealed that market value is positively associated with R&D expenditure and advertisement intensity in both the manufacturing and non-manufacturing firms.

Megna and Klock (1993) examined the contribution of firm's intangible capitals such as the R&D expenditure and patents to variation in firm value measured by Tobin's q. A sample of 11 firms operating primarily in the semiconductor industry for the period of 1972 to 1990 was taken for their analysis. Their empirical results revealed that both firms own R&D stock as well as rivals R&D stocks positively influences on Tobin's q. But, the stock of patents of rival firms is negatively and significantly influence on Tobin's q. The authors argue that patents and R&D are distinct measures of intangible assets since patents are marketable commodities and R&D is inchoative or just a beginning. Their result implies that intangible capital contributes to the variation

in Tobin's q but does not explain it completely. Huselid et al. (1997) introduced R&D intensity in their regression equation while analyzing the impact of HR managers capability on firm performance for 293 US firms using 1992 data. They found a negative and insignificant coefficient for R&D intensity. Similarly, Bharadwaj et al. (1999) incorporated R&D intensity as a control variable while examining the association between the IT investment and the q values for the US firm over a period of 1988-1993 and found a negative coefficient for R&D intensity.

Chung et al. (2003) examined the cross-sectional association between the market value of firms and R&D expenditure for US for the period of 1991–1995 and found a positive relationship between R&D expenditure and market value measured by Tobin's q. Hall (1993) analyzed stock market valuation of R&D investment for US manufacturing firms using Tobin's q for 2,480 firms from 1973 to 1991. The author treated R&D activities of the firm in two different ways namely, i) the R&D intensity as a flow variable and ii) the R&D capital stock constructed from the past R&D expenditures under the assumption of 15% annual depreciation rate. The results showed that the R&D expenditure is a strong and significant impact on Tobin's q.

Feng and Rong (2007) examined the association among firm's profitability efficiency, innovation capacity and firm value (Tobin's q) using a sample of 228 firms listed in Japanese electricity machinery industry for the period of 2000 – 2005. Their findings revealed that R&D intensity is basically negative and significantly related to Tobin's q whereas the Cumulative R&D intensity (representing long run impact) is positive and significantly related to Tobin's q. This indicates that R&D intensity is positively related to firm value in the long run but not in short run. Xu and Zhang (2004) examined the relationship between R&D intensity and the expected stock returns for a sample of 1613 Japanese firms listed in Tokyo Stock Exchange. They divided the entire sample period into three sub periods as the bubble-forming period, the burst-of-bubble period and the post-bubble period. They found that during the bubble-forming period the average stock return is slightly negatively associated with the R&D intensity but in both the subsequent periods the relationship is positive. They conclude that on an average the R&D intensity is helpful in explaining the expected stock returns even though the association is weak.

Munari and Oriani (2002) examined the impact of R&D expenditure on firm performance by estimating a hedonic model using data of 40 firms from six different Eastern European countries over the period 1982 to 1997. Their pooled OLS regression results revealed a significant and positive effect of R&D investment on Tobin's q but the coefficient is statistically insignificant for privatized firms. Connolly and Hirschey (2005) examined the impact of R&D expenditure on firm value for US manufacturing and non manufacturing firms. They found a positive and significant effect of R&D intensity on the firm value for both the manufacturing as well as nonmanufacturing sectors. They also found that the positive impact of R&D expenditure on Tobin's q in different firm size. Ho et al. (2005) examined the relationship between firm financial performances and the R&D intensity and advertisement intensity using Generalized Method of Moments (GMM). Their results revealed that R&D investment is positively related to holding period returns for manufacturing firms only. The results also indicated a significant negative coefficient for the squared term of R&D. These results suggest that indeed R&D investment and advertisement create value for firms but depending upon whether the firm is manufacturing and non manufacturing since the coefficient of R&D is not significant for non manufacturing firms.

Previous studies also found a nonlinear relationship between R&D and firm performance. Huang and Liu (2005) examined the relationship between innovation capital and firm performance for top 1,000 Taiwan firms. The authors included both R&D intensity and its squared term in their regression equation to examine the existence of non linear relationship between R&D investment and firm performance. Their results revealed that R&D intensity has a curvilinear inverted U-shape relationship with firm performance measured by return on assets as well as return on sales. Similarly, Bracker and Krishnan (2011) examined the impact of R&D intensity on Tobin's q using the S&P compustat database from the period of 1975 to 2007 for US and documented an inverted U-shaped relationship between R&D intensity and firm value. These studies support the concept of diminishing marginal return to each dollar invested on R&D.

In the Indian context, studies in this issue are scant but growing. Sarkar and Sarkar (2009) introduced R&D expenditure and advertisement expenditure as explanatory variables in examining firm performance. The sample for their study consisted of 500 top private sector companies listed in Bombay Stock Exchange for the financial year 2003. They used four performance measures namely; market-to-book ratio, Tobin's q, returns to assets and net value added to assets. They found that R&D expenditure positively influences firm value but not significant in the usual five percent level of significance. But, advertising intensity positively related to firm performance measured by market-to-book ratio and also by Tobin's q. They inferred that since R&D and advertising were taken as proxy for firm investment opportunities, R&D does not add any extra information

beyond that contained in advertising expenditure. However, this study is limited to one year. Chatterjee (2007) examined the private return on R&D stock for the Indian pharmaceutical sectors using Tobin's q estimation of the market value. His dataset was consisted of a panel of 315 pharmaceutical firms obtaining from Prowess database provided by Centre for Monitoring Indian Economy (CMIE) for the period of 1990 to 2005. His empirical results indicated that market positively valued R&D activities of Indian pharmaceutical firms. In addition, he also found an increase in depreciation rates of R&D implying higher obsolescence of R&D activities results in increasing returns to R&D for various subsets of the industry. Thus this study indicates that an increase in the private returns to R&D, the markets positively value more recent R&D in the industry.

Chadha and Oriani (2009) investigated the stock market valuation of R&D investment in India for a sample of 219 domestic and foreign firms publicly traded at the Bombay Stock Exchange for the period of 1991 – 2005. Their empirical findings revealed that the stock market positively valued the firm's R&D investment. They concluded that the investment on R&D has a higher market value than investment on tangible assets. Moreover, their analysis also revealed that in the techno-based industries the R&D investments of the firms are positively evaluated by the stock market.

Most of the above discussed empirical literature concludes that R&D investments are associated with higher level of firm performance and the markets positively value these investments. Some of the previous studies also found the relationship to be negative. There are also evident of the curvilinear relationship between the R&D intensity and firm valuations. However, large numbers of studies are concentrated on the data of well developed market economies and the studies for emerging economies are still rare. Moreover, the relationship may changes in different data period of different countries and also after controlling different firm specific factors. In the Indian case there are very few systematic studies have been done to investigate the relationship and more in-depth studies are required to justify the above conclusions.

3. EMPIRICAL DESIGN

The analysis is based on the following aspects: *first*, we considered only those firms from the manufacturing sector in India which are increasingly involved in R&D[ii]; *second*, we tried to incorporate the panel structure of our data that accounts for the unobserved firm heterogeneity. An unbalance panel has formed to incorporate the entry and exit of firms during the study period; *third*, we introduced the square term of R&D intensity in the explanatory variables to test the potential non-linear relationship, and also control for some other firm specific variables such as the import of technology, age of the firm, export intensity of the firms along with the variables that most of the studies control for. This gives us an extensive set of empirical specification to examine the inter-firm difference in the firm's market performance in an emerging economy like India. The following subsections will describe the variables those are used in the study and their analytical underpinning.

3.1. Dependent Variable

The dependent variable of our analysis is the market value of firm proxied by Tobin's q. Tobin's q has been extensively used to measure the market valuation and/or market performances of firm (e.g. Griliches, 1981; Hirchey, 1982; Hirchey 1993; Hall, 1993; Megna and Klock, 1993; Munari and Oriani, 2002; Pandit and Shiddharthan, 2003; Connolly and Hirschey, 2005; Chadha and Oriani, 2009). It is the statistic that serves as a proxy for firm's value or its market performance from an investor's perspective. Firm value measuring by Tobin's q is one way of looking beyond the impact of R&D on near-term profitability to its perceived net present value in the financial markets[iii]. By definition Tobin's q is the ratio between the market value of firm's financial claims (installed capital) and the replacement value of assets[iv].

Practically, construction of Tobin's *q* is a difficult as far as the developing is concerned. Since, a large proportion of the corporate debt is institutional and not actively traded in the debt market, and also most companies report asset values to historical cost rather than at replacement costs, its calculation is difficult (Sarkar and Sarkar, 2009). However, many studies used book value of debt and the book value of assets in place of their respective market values to resemble the original q. Chung and Pruitt (1994) revised the original Tobin's q formula and showed that their revised formula is a 96% resemble of original q. Following Chung and Pruitt and some Indian studies (e.g. Pandit and Shiddharthan, 2003; Chadha and Oriani, 2009; Bhattacharyya and Saxena, 2009), we calculate the market value of firm as the sum of market capitalization and the book value of debt capitals divided by the book value of total assets as a proxy for replacement cost of assets to obtain the Tobin's q value.

3.2. Independent Variables

R&D Intensity: The theoretical argument of the literature indicates that R&D investments of a firm contribute to future profits by generating intangible capitals that is evaluated by the stock market. Several studies like Griliches (1981), Hall (1993), Chadha and Oriani (2009) have adopted the capitalization method for investments made on R&D and other intangible capitals.

Also, some studies uses the square of R&D intensity in the regression assuming that there are diminishing marginal returns to R&D expenditures which exhibits a curvilinear relationship between R&D intensity and the performance variable (e.g, Huang and Liu, 2005; Bracker and Krishnan, 2011). According to Bracker and Krishnan (2011) while a positive coefficient of R&D intensity allows the firm value to increase, a negative coefficient on the squared R&D intensity allows for (but not necessary) managers overspending on R&D. If managers pursue R&D until marginal benefits equal marginal costs, they will be operating in the area of diminishing marginal returns. In some other studies lagged effect of R&D is used to determine firm value. However, one can argue that, the time lag can vary among industries, it can vary among firms within an industry, and also it can vary among different R&D projects within a firm. Because of this variation attempts to specify a fixed lag time are futile[v] (Morbey, 1988).

Our focus here to examine the importance of R&D as an influential source of intangible asset and a significant determinant of market value of the firm as measured by Tobin's q. R&D intensity is measured by the R&D expenditure of a firm as a percentage of net sales. However, market value of firm is not only affected by the firms R&D spending but also may be affected by a lot of other factors. In order to isolate the influence of R&D on firm value, as mentioned in Connolly and Hirschey (2005), the affects of other factors with predictable influences on the current market value of firm must be constrained. Hence, we also control for following firm specific variables. The constructions of these variables are reported in Table 1.

Advertisement Intensity: Hall (1993) argued that other important intangible assets firms include the value of brand names like trade mark, product differentiation, and good will of firms arising from product differentiation etc. These assets are mostly the product of investment in advertising activities. According to Ho *et* al. (2005) the contribution of advertising to value creation can be seen from its key role in a firm communication strategy in creating brand equity through the promotion of ideas, goods, or services. Ultimately the brand commands a higher price relative to competing products. Studies those find a positive and significant relationship between advertisement and firm value are Chauvin and Hirschey (1993), Hall (1993) and Ho *et* al. (2005) among others.

Firm Size: Firm size is commonly controlled in a wide range of R&D and firm performance literature (e.g. Chauvin and Hirschey, 1993; Ho et al., 2005; Munari and Oriani, 2007; Feng and Rong, 2007; Chadha and Oriani, 2009; Bhat and Narayanan, 2009). It has been argued in the literature that large firms may turn out to be more efficient as they are likely to exploit economies of scale, employ more skilled managers and the formalization of procedures that may lead to better performance. Such characteristics make the implementation of operations more effective allowing large firms to generate greater returns on assets or sales as well as to capture more value as a proportion of the value of the production, leading to a higher firm performance. However, when the large firm loose the control of top managers over strategic and operational activities within the firm then it will be less efficient than their smaller counterpart. Feng and Rong (2007), Chadha and Oriani (2009) found a positive and significant relationship between firm size and Tobin's q whereas Munari and Oriani (2002) found a negative and significant relationship between size and Tobin's q. Furthermore, study like Ho *et al*. (2005) found a negative and significant relationship between size and holding period returns. Hence, impact of firm size on firm market value is unclear.

Age: Following Pandit and Sidhharthan (2003) we also include age of the firm as an explanatory variable. It has been argued that older firms with an established history could be expected to fare better in the stock market. They could give experience-based economies of scale based on learning. They can enjoy superior performance compared to new comers and can avoid the liabilities of newness. However, older firms are prone to inertia, and rigidities in adaptability, which may lead to lower performance. Hence, the relationship is ambiguous.

Profit Margin: Previous studies also include profit margin as an explanatory variable in determining firm value. Connolly and Hirschey (2005) argue that historical profit margin is often the best available indicator of a firm's ability to generate superior rate of return during future periods. Thus it is reasonable to expect a positive valuation effect of profit margin. Following this argument we include after tax profit with respect to firm's net sales as an explanatory variable.

Export Intensity: Export intensity can be seen as one of the critical routs to firm growth and financially strengthen. Exporting firms can take advantage of a growing market abroad, while the same market indicates a sign of saturation in the home country. Moreover, exporting helps firms to gain economies of scale in production leading to price competitiveness. In certain industries, by selling abroad, firms can gain access to technology, and sophisticated consumers (Lee and Habte-Giorgis, 2004). This implies that the exporting firm can catch up the market environment quickly and become more successful in market in long run. Therefore, we expect a positive relationship between export intensity and Tobin's q.

Import of Technology: Improvement of production quality and the introduction of new product can be

managed by import of technology. The import of technology can be categorized as embodied and disembodied. While it is possible to improve the quality of product by using the imported materials and capital goods also called the embodied technology import, firms also upgrade their technology through the disembodied technology i.e. import royalties and lump-sum payments etc.(Bhat and Narayanan, 2009). An improvement of product quality through this process can be an advantage to the firm, which could influence the market valuation favourably. However, as Narayanan and Banerjee (2004) pointed out, technology import after a certain extent can increase the cost of production unless the firms gradually start lowering such import through in-house R&D. If this happens then higher import of technology reduces the firm's market performance. Following Pandit and Siddharthan (2003) and Bhat and Narayanan (2009) we use the intensity of import of technology in the regression.

Financial Leverage: Financial leverage has also been frequently controlled in the valuation of R&D by several studies. Financial Leverage can offer a potential returns to the investor if they efficiently used. However, a potential loss is also expected if the investment becomes worthless since the loan principal and all accrued interest on the loan still need to be repaid. So there is an increase in risk and therefore with an increase in risk market value of firm is expected to be fall. However, if taxes shields are valuable or debt reduce agency problem, financial leverage should promote firm's market value (Feng and Rong, 2007). Moreover, leverage could also act as a proxy for difficult to measure intangible assets, such as intellectual property, customer loyalty, or human capitals and firms that are more reliant on these intangible assets are likely to have lower financial leverage and possibly higher market value. Studies like Feng and Rong, (2007), Chadha and Oriani, (2009) found a negative and significant coefficient of leverage.

On the basis of the hypothesis spelt out in this section, the following basic regression model is specified.

Firm Value (Tobin's q) = f(R&D intensity, advertisement intensity, firm size, age of the firm, export intensity, intensity of technology import, profit margin, financial leverage).

Following Huang and Liu (2005) and Bracker and Krishnan (2011) we introduce the square term of R&D intensity to check the possible nonlinear relationship. The empirical specification of the testable model being

$$Tobin's\ q_{it} = a + b_1 RDI_{it} + b_2 RDI^2{}_{it} + b_3 ADI_{it} + b_4 SIZE_{it} + b_5 AGE_{it} + b_6 EXPINT_{it} + b_7 IMTI_{it} + b_8 PROF_{it} + b_9 LEV_{it} + u_{it} \ldots\ldots\ldots\ldots\ldots (1)$$

The subscript i and t refers to i^{th} firm operating in t^{th} year, a refers to the intercept term, the b_1, b_2,.....b_9 refers to the vector of regression coefficients and u_{it} refers to the disturbance term and follows the classical assumptions, $E(u_{it}) \sim N(0, \sigma^2)$.

4. DATA, SAMPLE AND METHODOLOGY

4.1. Data Sources and Sample

In order to carry out our analysis, we have collected the firm level data from PROWESS database provided by Center for Monitoring Indian Economy (CMIE). Although, CMIE data is available from the 1990s there were a lot of policy changes in the earlier years. Furthermore, firms are still responding to the new economic environment in these years. Hence we used data from more recent time period. We use firms those listed in the Bombay Stock Exchange (BSE) with available data from the year 2001 to 2010. To be included in the sample a firm must have the available accounting and financial data such as data on sales, R&D expenditure, and other necessary information to measure firm value.

Our final sample is based on the following criteria. First, those firms which reported zero sales value are eliminated from the initial data set. Since, only R&D incurring firms[vi] are taken for the analysis our second step in cleaning the data was to eliminate all firms that did not report R&D expenditures. After this process and some adjustment of possible outlier in the data structure, an unbalanced panel is formed for the analysis comprising 2382 firm-year observations[vii]. The data is unbalanced since not all firms report data for all the 10 years and data for some firms are missing for some years within the study period.

4.2. Econometric Methods used

We begin with pooled OLS model for the empirical analysis. However, by using the OLS model one essentially ignores the panel structure of the data. While it is possible to use ordinary multiple regression techniques on panel data, they may not be optimal (Johnston and Dinardo, 1997). This is because in OLS it is assumed that for a given individual, observations are serially uncorrelated; and across individual and time the errors are homoskedastic, which not always true. When errors are not homoskedastic, OLS estimates are consistent but inefficient leading to incorrect standard errors. Furthermore, the estimates of coefficients derived from regression may be subject to omitted variable bias.

With panel data, it is possible to control for some types of omitted variables even without observing them, by observing changes in the dependent variable over time. It controls for the omitted variables that differ between cases but are constant over time. It is also possible to use panel data to control for omitted variables that vary over time but are constant between cases. In the panel data model the collinearity among the variables are low (Baltagi, 2005). Panel data model can be estimated using both random and fixed effect[viii] estimation methods.

We use an unbalanced panel data because there are quite a few firms that have entered the industry, some firms are merged with others and some firms simply exit due to non performance during the study period. Moreover in the Prowess data base, for some firms, the balance sheet information is missing in some of the intermediate years.

We estimate the following fixed effects model which in very general can be specified as

$$Y_{it} = bX'_{it} + u_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where, i = 1, 2, 3, ……n (number of firms)

t = 1, 2, 3, ……T_k (number of years), and

$$u_{it} = \mu_i + v_{it}$$

Y is the dependent variable and X is the K-dimensional vector of explanatory variables, b is the vector of regression coefficients and u is the disturbance term. The term μ_i is time invariant and accounts for any unobservable firm specific effects not included in the regression. The term v_{it} represents remaining disturbance and varies over firms and times. It is assumed that the $\mu_i \sim$ IIN(0, σ_μ^2) and independent of $v_{it} \sim$ IIN(0, σ_v^2) for all i and t.

Whether the random effect estimator is appropriate over the fixed effect estimator is provided by the Hausman specification test[ix]. The Hausman test statistic is distributed asymptotically as chi – square with *k* degree of freedom under the null hypothesis that the random effects estimator is appropriate. A large and significant value of Hausman statistics (χ^2) favours the fixed effects estimator over the random effect estimators.

5. Empirical Results

Table 2, represents the average Tobin's q and average R&D intensity of the BSE listed publicly-traded manufacturing firms those involve in R&D during the period of 2001-2010. Firms are allocating an increasing portion of their budget outlays to R&D spending. It is observed that the number of firm investing in R&D has increased significantly from 132 in 2001 to 307 in 2010. Both the mean value of Tobin's q and R&D intensity has grown from 0.69 in 2001 to 1.46 in 2010 and 0.62% to 1.31% respectively for the same period. This gives the primary motivation to examine the impacts of the R&D spending on firm market performance.

Table 3, depicts the descriptive statistics of the sample firms in our study. It is observed from the table that, mean value of Tobin's q is more than 1 i.e. (1.29) indicating the market assesses current asset values more highly than it would the asset's value in its next best alternative use, its replacement cost for our sample firms. The average R&D intensity is still lower. On average the firms in our sample spent about 1.14 percent of their sales revenue on R&D with a minimum of R&D intensity of 0.0014 percent and maximum of 34.4 percent.

Table 4 depicts the correlation coefficients of the explanatory variables. It is observed from the table that the correlation coefficients are low for most of the cases (except the squared variables) but significant indicating the existence of multicolinearity. However, this may not be serious problem since most of the coefficients are lower than 0.5. It is also evident that the all explanatory variables are significantly correlated with the dependent variable except import of technology intensity.

5.1. Regression Results

The regression results of both pooled-OLS and fixed effects estimation are shown in Table 5. To begin with we estimate equation (1) using OLS model. The potential heteroskedasticity is corrected using Whites method. The whole model reaches a significant level ($F = 30.18$, $p < 0.01$) and explain the variation of 18 percent in firm value. The regression results obtained are free from problem of heteroskedaticity (the reported t-statistics are White corrected and hence provide robust statistical estimates).

It is evident that all of the variables (except AGE) in the analysis are highly significant and in the expected direction. R&D intensity has a positive and significant effect whereas its square term has a negative and significant impact on Tobin's q indicating a curvilinear relationship (inverted U-shaped) between R&D intensity and firm value. This means that there is a positive contribution of R&D to firm value at the beginning of investment, but, when the investment arrives at an optimal level continuous R&D expenditure reduce the firm value. The curvilinear relationship also indicates that firm which spending moderate level of R&D are performing well in the market. This result is consistent with Huang and Liu (2005) who finds similar curvilinear relationship between R&D expenditure and return on sales for Taiwanese firms and Bracker and Krishnan (2011) who finds similar results for US firms.

Advertisement intensity is turned out to be significant and positively related to Tobin's q. It seems that advertising contributes to firm value by creating brand

equity through the promotion of ideas, goods, or services. Similar results have been found by previous studies which examined effect of advertisement on firm value (e.g. Chauvin and Hirschey, 1993; Hall, 1993; Ho *et* al., 2005)

Age does not have a significant impact on firm value. Firm size seems to be highly significant and positively associated with firm value indicating large firms are performing better in the market by exploiting economics of scale. This result is consistent with the finding of Chadha and Oriani, (2009) that found a positive and relationship between firm size and Tobin's q for Indian manufacturing firms. Profit and export intensity are also turning out to be significant and have a positive impact on Tobin's q although the coefficients are very low. This implies that higher the profit margin higher will be the market value of firms. The positive relationship between export intensity and firm value implies that the exporting firms catch up the market environment quickly and become more successful. Import of technology intensity and financial leverage are negatively related to Tobin's q. The negative impact of technology import on firm value indicates that higher technology imports increase the cost of production and hence reduces the firm's market performance. Highly leveraged firm are not able to perform better in the financial market.

By performing an ordinary least squares estimation with the assumption of each observation is independent and identically distributed, we ignore the panel structure of data set. To control the panel structure of the data set equation 1 is estimated using panel data method (fixed effects and random effects models). This also provides the robustness of our findings. The highly significant χ^2 value for Hausman test (48.28) allows us to prefer the results of fixed effect model. The whole model reaches a significant level ($F = 9.00, p < 0.01$). Once again the R&D intensity and its squared term turned out significant and show an inverted U-shaped relationship with Tobin's q. These results suggest that if a firm spends too much on R&D, then they are undertaking negative Net Present Value opportunities. Too much R&D spending can be just as harmful as not enough R&D spending. Other variables such as advertisement intensity, firm size, import of technology and profit are also coming out significant on determining firm value. The sign or directions are as expected and similar to results of ordinary least squares estimation.

6. CONCLUSIONS

During the last few years firms and industries form the manufacturing sector have increasingly involved in R&D. Whether this increasing involvement in R&D activities of firms has a favorable impact on their market performance or it adds the cost to firm be still an empirical issue in the policy perspective as far as India is concern. The present study made an attempt to examine the impact of firms R&D expenditure on firm value using Tobin's q approach for the BSE listed manufacturing firms over the period of 2001 to 2010. The study analyzes the relative impact of R&D on firm value on the structure conduct performance paradigm controlling some other firm characteristic variables viz. firm size, age of the firm, advertisement, technology imports, and export of goods, financial leverage and also with profit margin.

The study finds that, there is a significant curvilinear relationship between R&D intensity and firm value indicating the diminishing marginal return of R&D expenditure. This result is consistent with Huang and Liu (2005) for Taiwan and Bracker and Krishnan (2011) for United States. This result suggests that investment in R&D have a positive impact on the market value of firm at the beginning, however, excessive investments bring a negative impact on firm value. Thus it can be suggested that managers of the firms should treat the R&D expenditure as assets to the firm as long as the expenditure is moderate otherwise it incur cost to firms. Firm shouldn't overinvest and underinvest on R&D activity as too less and too much is not always better. Firms should make an optimal level of their investment on R&D and establish the strategy of intellectual capital investment to perform well in the market. In addition to R&D the present study also identified other firm specific characteristics to be important in explaining the firm's market performance. All the variables undertaken in the study are significantly influence the Tobin's q and hence firm value. Advertisement, firm size, profit margin and export intensity are significantly and favorably influence the firm value whereas technology imports and financial leverage are adversely affect firm value. Age of the firm does not have any significant influence on firm value.

This study is limited to the following ground. Although this study controlled a number of firm specific variables to explain the firm value, it does not claim that all the potential determinants of firm value have been controlled. Some other variables like managerial remuneration, market concentration and the industry effect may also influence the firm value. This study can be extended by incorporating these variables as well as by a systematic comparison of high R&D intensive industries and low R&D intensive industries. Second limitation of this study may be the fact that it does not take care of the possible endogeneity problem. Future research may therefore be encouraged.

NOTES:

i. Firm value is regarded as the forward looking measure expressing the stock market expectation about firm's future performance.

ii. By selecting the sample firms those involved in R&D are expected to provide a direct way of investigating the impact of R&D expenditure on firm performance.

iii. The main advantage of the valuation ratio is its embodiment of current financial market expectations. However, important limitations are the reliability of market valuation data in countries where capital markets are not broad or well developed and measurement errors with respect to the replacement cost of the capital stock.

iv. See .Tobin, J. (1969). A general equilibrium approach to monetary theory. Journal of Money Credit and Banking ,1 (1), pp. 15–29.

v. While employing a lag can provide more accurate impact of R&D investment on firm performance, obtaining a lagged value in the unbalanced panel is quite difficult and misleading.

vi. Only those firms which reported continuous data for at least four consecutive years with at least five years appearance in the study period are considered for analysis. Because these firms are incurring the R&D expenditures more than one-third of the study period, we termed them as R&D incurring firms.

vii. The total number of sample firms used here are 326 individual firms but the panel is unbalanced.

viii. Fixed effects includes 'within effects' estimation which takes firm specific fixed effects where the focus is on time series data, into account and 'between effect' estimators which explore cross-sectional dimension by using the firm means over time.

ix. Hauseman (1978) provides a test wherein the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects. The Hausman test compares the two estimators FE and RE and test whether these estimators are significantly different.

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Tables and Charts Used

Table 1. Construction of Variables

Variables	Notation	Variable Measurement	Expected Sign
Tobin's q	Tobin's q	(Market value of firm's equity + book value of debt)/(Book value of total assets less miscellaneous expenditure and depreciation) Market value of equity = 365 days average closing price*Number of share outstanding Book value of debt = sum total of both secured and unsecured borrowings	
R&D intensity	RDI	(R&D Expenditure/Net Sales)*100	+
Advertisement intensity	ADI	(Advertisement Expenditure/ Net Sales)*100	+
Age of the firm	AGE	No. of Years since incorporation of the firms i.e. Difference between the Year in consideration and the Year of establishment of a company.	+/-
Size	SIZE	Ln (Net Sales), Net sales = Total sales - inventories	+/-
Profit Margin	PROF	(Profit after tax/ Net Sales)*100	+
Export intensity	EXINT	(Export of goods/Net Sales)*100	+
Import of Technology Intensity	IMTI	Sum of Import of Capital goods and Licenses fees, Royalties and Technical Knowhow fees as percentage of Net sales	+/-
Financial Leverage	LEV	Total debt as a percentage of total assets	+/-

Table 2. Tobin's q and R&D intensity by Year

Year	No.of Firms	Tobin's q	R&D intensity
2001	132	0.698	0.626
2002	159	0.764	0.782
2003	151	1.171	1.012
2004	193	1.346	1.115
2005	223	1.363	1.113
2006	276	1.493	1.092
2007	316	1.827	1.155
2008	316	0.864	1.309
2009	309	1.389	1.381
2010	307	1.462	1.310

Note: The numbers of firms in this table are the total number of firms reporting R&D expenditure in the particular year.
Source: Calculated by authors based on the sample extracted from the Prowess database.

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Tobin's q	2382	1.299	1.164	0.123	10.723
Age	2382	35.638	18.648	2	109
Size	2382	7.981	1.734	2.415	14.940
RDI	2382	1.146	2.655	.0014	34.411
ADI	2382	0.896	2.217	0	20.199
LEV	2382	29.603	19.973	0	128.660
PROF	2382	5.838	21.776	-576.241	131.775
EXPI	2382	20.457	28.539	-151.783	181.377
IMTI	2382	3.430	8.549	0	87.697

Source: Calculated by authors based on the sample extracted from the Prowess database.

Table 4. Correlation Matrix

Variables	Tobin's q	AGE	SIZE	RDI	ADI	LEV	PROF	EXINT	IMTI
Tobin's q	1								
AGE	.056**	1							
SIZE	.282**	.352**	1						
RDI	.192**	-.136**	0.006	1					
ADI	.247**	.102**	.142**	.075**	1				
LEV	-.162**	-.153**	-.123**	-.077**	-.166**	1			
PROF	.181**	0.007	.171**	.106**	0.028	-.323**	1		
EXINT	.078**	-.196**	-.061**	.254**	-.082**	.054**	.135**	1	
IMTI	0.005	-0.016	.116**	0.039	-0.016	-0.018	0.038	.143**	1

*Notes: * Significant at 5% level; ** significant at 1% level; two-tailed test; N=2382*
Source: Calculated by authors based on the sample extracted from the Prowess database

Table 5. Regression Results for Determinants of Firm Value

Dependent Variable Tobin's q		**(N = 2382)**	
Variables	**OLS (Robust)**	**Fixed Effects (Within) Estimates**	**Random Effect Estimates**
Constant	-0.118 (-1.14)	-1.063 (-3.24)***	-.339 (-1.85)*
RDI	0.116 (5.07)***	.0529 (1.72)*	.1037 (4.54)***
RDI^2	-.0034 (-2.57)***	-.00390 (-3.09)***	-.0046 (-4.21)***
ADI	.1034 (6.60)***	.0403 (1.61)*	.0889 (5.91)***
AGE	-.0018 (-1.34)	.00703 (0.90)	-.00197 (-0.88)
SIZE	.168 (12.25)***	.2610 (5.23)***	.2040 (9.01)***
EXINT	.00246 (2.31)**	-.00169 (-1.39)	.00017 (0.17)
IMTI	-.00541 (-2.37)***	-.00380 (-1.67)*	-.00394 (-1.77)*
PROF	.00454 (2.05)**	.00194 (1.73)*	.00273 (2.64)***
LEV	-.00381 (-3.07)***	.0000252 (0.01)	-.00252 (-1.69)*
R^2	**R^2 = 0.1810**	R^2 (within) = 0.0381 R^2 (between) = 0.1573 **R^2 (overall) = 0.0873**	R^2 (within) = 0.0289 R^2 (between) = 0.2928 **R^2 (overall) = 0.1646**
F- statistic	F(9, 2372) = 30.18***	F(9, 2047) = 9.00***	Wald $\chi^2(9)$ = 193.82***
χ^2 for Hausman Test	**χ^2 (9) = (41.28)*** *Fixed Effects Chosen Over Random Effects*		

Two-tailed test the hypothesis that each coefficient is different from zero, t-values reported in brackets
**** Significant at 1% ; ** Significant at 5% ; * Significant at 10%*

Source: Calculated by authors based on the sample extracted from the Prowess database.