Available online at www.elixirpublishers.com (Elixir International Journal)

Finance Management

Elixir Fin. Mgmt. 48 (2012) 9446-9456

ISSN: 2229-712X

Business house affiliation and other factors determining R&D intensity in selected Indian firms

K.S.Sujit and Purna Chandra Padhan

Institute of Management Technology, P.Box. No345006, Dubai.

XLRI, School of Business and Human Resources, C H Area(E),Jamshedpur-831001, Jharkhand, India.

ARTICLE INFO

Article history:

Received: 16 May 2012;

Received in revised form:

15 June 2012;

Accepted: 12 July 2012;

Keywords

Business house affiliation,
Global competitiveness,
Research and development,
Profitability.

ABSTRACT

The decision to spend on Research and Development (R&D) is very crucial for the growth of any firm. This study explores the determinants of R&D intensities in selected Indian firms that spend on R&D activities. The impact of business house affiliation on R&D activities is also taken as a crucial factor determining R&D activities. The study found that R&D behavior for the period 2003-2009 is different from the year 2010. The year 2010 being the recovery year there has been significant rise in R&D spending among the selected firms. As there are some interrelated variables in the model, the simultaneity in the models is verified with Hausman tests and then two-stage least square method is applied for the empirical estimation and analysis. Outward orientation, profitability, imports of capital goods, advertisement etc. turned out to be important determinants of R&D intensity. Business group affiliation as such has a negative role in R&D intensity except for top-50 business houses in certain year.

Introduction

Diversified business houses contribute significantly to the economic growth of emerging markets around the world. These diversified business houses, owned by a particular family, are having significant resources and power in their control to influence markets in the presence of market imperfections and information asymmetry. In emerging markets, business house affiliation has significant potential benefits as it becomes less costly for the affiliated firms to acquire necessary inputs from capital, labour and product markets. Such affiliation comes in handy to attract new investments, joint ventures and brand image in the markets due to their strong presence. In Asia, the growth of family owned business has been impressive not just as regional players but also as global players. Across the ten Asian markets, family businesses account for around 50 per cent of all listed companies, 32 per cent of total market capitalization, 57 per cent and 32 per cent of all listed companies' employees in South Asia and North Asia respectively (*Asian Family Business Report, 2011)*.

Indian family owned business also has grown significantly after post-independence but the journey can be termed as remarkable after India started its liberalization policy in the year 1990. According to Asian family business report 2011, market capitalization of Indian family business as a share of nominal GDP rose from 9 percent in 2001 to 46 percent in 2011. India has the highest percentage share of family businesses in Asia, accounting for 67 per cent of total listed companies with market capitalization of more than $50 million.

The Indian business group, like many other business groups around the world, is typically a collection of legally independent firms in a wide variety of industries. The group is normally associated with a particular family and the firms in the group are linked through interlocking directorships and financial ties that include cross holding of equity, internal loans, and debt guarantees (Bandyopadhyay & Das, 2005). All these translate into performance of the firm and group. Khanna and Rivkin (2001) found that business groups affect the broad patterns of economic performance in 12 emerging markets. Similarly Chang and Hong (2000) studied the *chaebols* in Korea which are defined as a gathering of formally independent firms under single common administrative and financial control, and are owned and controlled by certain families. *Chaebols* operate an internal labor market, thereby utilizing scarce managerial resources. They also share technological resources among group-affiliated firms by transferring key personnel to affiliated companies. Group-wide advertising generates considerable scale and scope economies (Sea and Jaebum, 2002).

Most of the studies on business houses concentrated on explaining the difference in performance due to its affiliation. It is fairly well established that in emerging markets group affiliation significantly influence the performance of the firm. However, there are very few studies which focused on the difference in research and development (henceforth R&D) expenditure across business houses as compare to other standalone firms. Do business houses act like any other standalone firms in the market especially in taking crucial decisions on R&D expenditure? This study bridges the gap by addressing the role of business houses affiliation and other important variables in explaining R&D intensity of the firms in India.

The rest of the paper is organized as follows: The second part deals with a brief review of existing literature in this domain. The third part focuses on the hypothesis emerged out of previous literature. The fourth part spells out model specification, data and sample used in this study. The fifth part brings empirical finding of the paper and the sixth part concludes the study.

Review of Literature

Technological progress through research and development (R&D) activities has been widely recognized as a key factor

Tele:
E-mail addresses: kssujit@gmail.com

contributing towards economic growth and competitiveness of the economy. With the introduction of product patents in most countries, the role of R&D is even substantially important for the survival of the company. At firm level, objective of R&D activities is to gain competitive advantage which would help the firms to grow and diversify over time (Hay and Morris, 1991). Investment in R&D activities is often considered as risky and hence the decision to fund is of crucial importance.

In the traditional industrial organization (IO) literature, R&D activity was considered to be an important conduct variable that can affect performance of the industry. It also stresses that the R&D activities are linked to industry structure and has the ability to create barriers to entry. The study of Mason (1939) and Bain (1951) linked the conduct or behavior of the firms to the structure of industry. Their model specifies a unidirectional relationship which goes from structure of industry to conduct and finally to the performance. Entry barrier was considered to be an important determinant of profitability differences. Research and development activities act as a significant contributor in increasing entry barriers.

In seventies, the concept of strategic group gained popularity in explaining why some firms perform better than others within the same industry. Hunt (1972) coined the term strategic group while conducting an analysis of the appliance industry and discovered a higher degree of competitive rivalry than suggested by industry concentration ratios. Strategic groups are those companies within an industry that have similar combinations of strategies. Studies such as Caves and Porter (1977), Nagesh (1990), have tried to introduce mobility barriers and the concept of strategic groups within an industry to explain intra-industry differences in profitability. In case of strategic differences among different group of firms within the same industry are, among other factors, reflections of tangible and intangible assets Porter (1979). Using this Nagesh (1990) used foreign multinational companies and local companies as two strategic groups. He concluded that the foreign multinational companies get greater support from the mobility barrier than the local companies. The advantages are more in knowledge and skill intensive industries. With the growth of family owned companies it is not difficult to articulate that within local companies there are significant variations in (tangible and intangible) assets and performance. By segregating different groups in terms of business house affiliations would certainly shed more light on the behavior of the firms.

Resource-based view of business groups implicitly assumes that there exist market failures. Increasing the scale or scope of a firm is valuable only if these economies of scale and scope cannot be exploited through market transactions or contracts. In emerging economies markets and information are not perfect hence firms it is efficient to pool different businesses into a group to capitalize on those economies (Molen, 2005). Resource-based view analyzes competitive advantage at the firm level [Lippman and Rumelt, 1982; Wernerfelt, 1984; Barney 1991, 2001]. These studies see firms as a collection of inherent capabilities. These capabilities are in terms of resources (tangible and intangible) held by the firm which help in value creation and also resist the duplicative efforts. Preventing duplicative efforts is particularly important as in the presence of high competition, rivals try to imitate, acquire or try to substitute resources, which are sources of competitive advantages (Barney, 1991). Therefore in order to maintain the competitive advantage, the firm's should not only innovate, but also continuously innovate (Porter, 1990). One such market-based investment that may lead to sustained firm competitive advantage is R&D activities.

Investments in R&D may lead to the development of new products with distinctive customer benefits in an environment of technological change. It also increases the competitive advantage of the firm. However, investments in each of these assets need to be justified in terms of long-term economic gains or shareholder value [Srivastava, et.al. (2001)]. In this situation the role of business house is imperative as they could generate internal as well as external funds easily and take advantage accordingly. While investing in intangible assets although reduces short-term profits, but it can significantly boost long-term profits. The pressure of positive short-term profit is generally low for the business houses than the other standalone players in the market. Research and Development (R&D) expenditure often competes with advertisement expenses in the budget. These investments have an immediate negative impact on quarterly financial performance which prompts many executives to cut R&D and advertisement investment during difficult economic conditions. Additionally, pressure may be exerted on managers to sacrifice these intangible investments to maintain short-term earnings growth [Drucker, 1986; Jacobs, 1991; Porter, 1992; Trina and Srini 2003]. This may not be the case with business houses which has access to both internal and external sources of fund.

Investing in intangible assets (such as advertising and R&D expenditures) has a tangible effect on a company's performance (Pearl, 2001). Advertisement expenditure is seen as a crucial variable to promote brand and increase sales revenue. Both of these intangible investments may, however, be critical to the long-term success of firm (Trina and Srini, 2003). Advertisement can have a positive effect, if it is complementing the R&D initiatives which help in improving the scale and scope economies. It can also be a negative effect if it is substituting R&D initiatives in the firm to improve short-term profit of the firm.

Apart from business house affiliation there are many other important determinants of variations in R&D activities. Present study includes these variables after carefully reviewing the previous literature. In emerging markets firms prefer importing technology as it is less risky for them to import than to go for R&D. This has gained popularity and widespread acceptance as an important strategy for growth after globalization wave. Royalty payment, intra-firm transfer of technology through foreign direct investment or foreign equity participation etc. are seen as options to get up-to-date technology as suggested by these studies [(Link,1983; Bell and Scott-Kemmis, 1985; Desai, 1985; Pandit and Siddharthan, 1998; Narayanan, 1998; Romijn, 1996; Narayanan, 2004].

Studies such as Katrak (1989), Romijn, (1996) and Narayanan, (1998) have used technology transfer through the supply of machinery and equipment where the technology is embodied in the imported capital good. The firm may then use internal R&D efforts to adapt, assimilate and develop imported technology. Katrak (1989) found that imported technology helped in promoting R&D activities in the firms. Similarly, Siddharthan (1992) and Siddharthan et.al (2002) found it to be complementary.

Profit and R&D expenditure relationship runs bi-directionally. Profit being the important source of funding R&D initiatives of firm has a positive relationship confirmed by

Kotabe (1990), Mansfield (1963) and Hufbauer (1970). On the other hand, persistent spending on R&D activities is linked to higher productivity and profitability. Börje and Haans (2008), Jaffe (1986), Geroski et al. (1993) found a positive and statistically significant relationship between the firm's own innovation and profit in the U.K

R&D expenditure of firms may also depend upon the outward orientation of the firm. An outward oriented firm sees both domestic and external market as an important avenue for its growth and expansion. It can serve the external market through export or outward direct investment. Braga and Willmore (1991) for Brazil; Kumar and Saqib (1996), Kumar and Agarwal (2000) for India have found that diversification of firms into international markets significantly increases both their probability to do R&D and ability to do R&D more out of total sales Pradhan (2003)

In an attempt, Hymer (1960), later extended by Kindleberger (1969) and Caves (1971), mentioned that firms undertaking investment abroad must possess some monopolistic advantages like product differentiation, management skill, patents and superior technology, control of the supply of key raw materials, economies of scale, etc. which they can profitably exploit abroad by internalizing production rather than exporting from home country or licensing those advantages to a third party abroad.

Based on the above discussion on various important variables that explains the variations in R&D activities the study intend to test certain hypothesis discussed in the next section.

3. Hypothesis of the Study

R&D initiative is a very risky and costly affair. Therefore the decision to invest on R&D competes with other budget of the firm. It is also fairly established that firms to spend on intangible investments like R&D sacrifice short-term profits to gain long-term profits. Large firms are often seen spending on R&D activities to remain large [Schumpeter, 1943; Brozen 1951; Mansfield, 1963; Symeonidis, 1996]. However it is not clear about role of business house affiliation in determining variations in R&D behavior in the economy. Business houses in emerging markets are not only large but also owner of critical resources as well as internal capital and labour markets. Other important variables, as discussed in literature could influence the R&D intensity of firm. In lieu of this, the following hypotheses were formulated for this study.

Hypothesis 1: Business house affiliation explains the variations in R&D intensity.

Hypothesis 2: Past profits determine variations in R&D intensity across industries.

Hypothesis 3: Advertisement intensity affects the R&D intensity

Hypothesis 4: Outward orientation has a positive relationship with R&D intensity.

Hypothesis 5: Import of technology and technology transfer affects the R&D intensity.

Data Sample, Variables and Model Specifications

The data were collected form Prowess database provided by Center for Monitoring Indian Economy (CMIE), Mumbai. It comprises data (both financial and non-financial) on more than 22000 Indian companies. The coverage includes public, private, co-operative and joint sector companies, listed or otherwise. Prowess is the largest database on the performance of Indian companies. The database includes a major part of large manufacturing firms and a relatively small proportion of the small or medium firms. It reports two R&D figures i.e. R&D on capital account and R&D on current account. The R&D on capital account is the capital expense incurred by a company on research and development. The information is sourced from the particulars required under the Companies (Disclosure of particulars in the report of the Board of Directors) Rules, 1988 and not from the income & expenditure statement of companies. In other words, R & D expenditure on capital account is not sourced from profit and loss account statement. Many times, companies do not disclose revenue expenditure on research and development separately because it is a relatively very small amount. As a mandatory requirement, companies are required to disclose this information as part of report of Board of Directors. As part of mandatory requirement, companies are required to show research and development expenditure on revenue as well as capital account which helps in estimating total research and development expenses incurred by a company. Unlike in the U.S., Indian firms are allowed to treat part of their R&D expenditures as an expense and capitalize the rest. This means that R&D data reported by Indian firms are not equivalent to what would be reported by U.S. firms under the FASB reporting conventions for R&D, which treats all R&D expenditures as an expense.

It is important to note that in many companies the R&D figure is mentioned as zero but actually it is positive in many cases. The disclosure norms under the Indian Companies Act 1956 require companies to report categories of expenditure accounting for more than 1% of turnover. Since R & D expenditure in many firms in India are often less than 1%, firms do not report it, even though positive R&D expenditure takes place (Ministry of Statistics and Programme Implementation)[1]. This may mislead the results of the study; hence the study included those firms which mentioned positive R&D expenditure in either current or capital account. Also firms with zero sales figures for the entire period were dropped from the analysis. Overall there are 3164 firms taken from 27 industries for this study. These firms by no means represent the whole manufacturing sector of India but the availability of firm level data restricted the study to confine with the existing sample which remains the limitation of the study.

All companies in the Prowess database are mapped to an ownership group in CMIE's classification of ownership groups. The mapping reflects the structure of the ownership of the equity shares and the management control of the companies. CMIE uses the available data, its intelligence and judgement in associating a company to a business group or any ownership heading in the ownership structure.

Variables

In this study both continuous and categorical variables have been used. In order to capture the impact of business houses, the study followed the classification given by CMIE Prowess database. CMIE database classifies business houses into the "Top-50 business houses", "Large Business houses other than the top fifty", "Foreign Business Houses" and rests are all others business house categories. In order to represent these four categories the study used three dummy variables.

A. Business house affiliation is captured by the three dummy variables to represent four categories.

[1] Sources: http://mospi.nic.in/nscr/css.htm)

a. **Top** : Dummy variable value 1 if the firm is a member of top 50 business houses otherwise zero.
b. **LBH**: Dummy variable value 1 if the firm is a member of Large Business Houses otherwise zero.
c. **FBH:** Dummy variable value 1 if the firm is a member of Foreign Business Houses otherwise zero.
Other independent variables are as follows:
B. In order to capture the past performance of the firm the study used **Profitability (Prof)** which is the average PAT (Profit after Tax) for the period 2003-2009 to the average sales revenue of the same period.
C. Advisement Intensity (Adv) is simply the ratio of Average Advertisement expenditure for the period 2003-2009 to the average sales revenue of the same period.
D. Technology Transfer is captured by a proxy **Royalty Intensity (Royal**) which is the average royalty payment for the period 2003-2009 to the average sales revenue of the same period.
E. Imported Technology is captured by Import of capital intensity **(Import)** which is the average import of capital goods for the period 2003-2009 to the average sales revenue of the same period.
F. Import of Finished Goods (Impfinish) is captured by Import of finished goods intensity which is the average import of finished goods for the period 2003-2009 to the average sales revenue of the same period.
G. Outward orientation is captured by two variables
Global Competitiveness (GC): Average investment abroad for the period 2003-2009 to the average sales average revenue of the same period.
Export orientation (Expog): Average exports of goods for the period 2003-2009 to the average sales revenue of the same period.

Model Specification

The objective of this study is to capture the determinants of R&D intensity in selected firms across Indian industries. For the analysis both continuous and categorical variables are taken into account. Business house affiliation is a categorical variable and all other independent variables are expressed in terms of intensities. R&D activities are generally affected by past activities of the firm. Today's spending on R&D depends on past behavior of the firms. This has been captured in two ways. The current year's R&D expenditure is taken as a function of the variables of period 2003-2009. R&D activities are also considered to be continues i.e. once it is taken then the firm has to continue till it is completed or it is canceled. Hence past record of R&D plays a significant role in firms' behavior. In order to take this into account the study also used average R&D for period 2003-2010 as a function of independent variables for a period of 2003-2009 (average values). This is to avoid any unexpected fluctuations in the R&D behavior of firm. Average of past years is taken due to the fact that it is often difficult to ensure which lag is suitable in cross section studies especially in case of R&D decisions where past performance is considered important. This normally misses the year specific impacts but at the same time it gives importance to all the years. Prior to the year 2003 data has not been included as the study assumes all the important effects can be capture with the existing period.

The R&D model is estimated by taking average R&D intensity as well as current years' R&D intensity. To add variability, the study used R&D in current account and R&D in capital account separately.

The R&D models are as follows:

$$R\&D_{ia,} = \alpha_0 + \beta_1(Top)_i + \beta_2(LBH)_i + \beta_3(FBH)_i + \beta_4(Adv)_i + \beta_5(Royal)_i + \beta_6(import)_i + \beta_7(GC)_i + \beta_8(Expog)_i + \beta_9(Prof)_i + \varepsilon_i \quad \text{.....(1)}$$

$$R\&D_{ic,} = \alpha_1 + \delta_1(Top)_i + \delta_2(LBH)_i + \delta_3(FBH)_i + \delta_4(Adv)_i + \delta_5(Royal)_i + \delta_6(import)_i + \delta_7(GC)_i + \delta_8(Expog)_i + \delta_9(Prof)_i + \mu_i \quad \text{.....(2)}$$

Here, $R\&D_{ia,}$ represents average R&D intensity for the period 2003-2010 of the i[th] firm in the sample. In second model the $R\&D_{ic,}$ represents the R&D intensity of current period i.e. 2010. The models are tested for both R&D expenditure on current and capital account.

In order to test the presence of simultaneity between advertisement intensity and R&D intensity the study used the following two equations simultaneous model.

$$R\&D_i = a + \beta_1 Top_1 + \beta_2 LBH_2 + \beta_3 FBH_3 + \beta_4 Adv_i + \sum \alpha_j X_j + \varepsilon_i \quad \text{.....(3)}$$

$$Adv_i = \delta + \gamma_1 Top_1 + \gamma_2 LBH_2 + \gamma_3 FBH_3 + \gamma_4 R\&D_i + \gamma_5 Prof_i + \gamma_6 Impfinish_i + \mu_i \quad \text{.....(4)}$$

In equation-3, the R&D intensity depends on three group affiliation dummies, advertisement intensity (Adv) and X vector of j control variables. Control variables are past profitability (prof), Royalty (royal), Import intensity (import), Global competitiveness (GC) and Export intensity (expog). In the fourth equation advertisement is a dependent variable depends on three group affiliation dummies, R&D intensity (R&D) and past profitability (prof) and Import of finished goods (Impfinish).

Assuming dummy variables and $\sum \alpha_j \mathbf{x_j}$ to be exogenous if there is no simultaneity problem then the endogenous variables i.e., $R\&D_i$ and Adv_i are mutually independent. It also means that Adv_i and $R\&D_i$ should be uncorrelated with ε_i and μ_i in equation 3 and 4 respectively. On the other hand, if there is simultaneity, Adv_i and $R\&D_i$ should be correlated with ε_i and μ_i. To find out which is the case, the Hausman test proceeds by obtaining the reduced-form equations (RFEq) from the above equations and followed the two step procedure of Hausman test as provided by Pindyck and Rubienfeld in Gujrati (2003).

RFEq :

$$R\&D_i = a + \beta_1 Top_i + \beta_2 LBH_i + \beta_3 FBH_i + \beta_4 Impfinish_i + \sum \alpha_j X_j + v_i \quad \text{.....(5)}$$

RFEq:

$$Adv_i = \delta + \gamma_1 Top_i + \gamma_2 LBH_i + \gamma_3 FBH_i + \gamma_4 Impfinish_i + \sum \alpha_j X_j + w_i \quad \text{.....(6)}$$

Where v_i and w_i are the reduced-form error terms. Under the null hypothesis of no simultaneity, the correlation between $\widehat{\mathbf{vi}}$ and μ_i should be zero, asymptotically. Also the correlation between $\widehat{\mathbf{wi}}$ and ε_i should be zero. This can be simply tested by running regression by adding $\widehat{\mathbf{vi}}$ and $\widehat{\mathbf{wi}}$ as an independent variable in equation-4 and 3 respectively. If the coefficient of $\widehat{\mathbf{vi}}$ and $\widehat{\mathbf{wi}}$ is statistically zero, one can conclude that there is no simultaneity problem. This conclusion however, will be reversed if this coefficient is found to be statistically significant.

For estimation of these equations the study has used both multiple linear regression model and two stage least square model. If there is no simultaneous problem then ordinary least

square (OLS) and two stage least square (2-SLS) results will not be different.

Empirical Analysis

The descriptive statistics, in table-4, shows some preliminary understanding about the nature of the data. The mean of dependent variables are high for current period than the average of the whole period. This shows that firms do not spend on R&D expenditure uniformly across different years. The year 2010 being the year of recovery after the recent global financial crisis and recession, the firms' conduct with respect to R&D is different. Higher R&D could be a tool to recover from the global meltdown. The mean, standard deviation is higher in the year 2010 as compared to the average period. The coefficient of variation is lower which indicates that there is uniformly higher R&D intensity in general for the year 2010. The values of skewness and kurtosis differ significantly from zero and 3 respectively. This is normally the case with the distribution of firm R&D intensities within an industry. The distribution is known to be skewed towards larger values, with a large portion of non-R&D-performing firms (Cohen and Klepper 1992). The calculated Jarque-Bera statistics for all the variables are very high and p-value suggests that the sample is not normally distributed.

In Table-3 R&D intensities are calculated for different periods. For the whole industry including the firms which are not reporting R&D the intensity for the period 2003-2010 is lower than the R&D intensity of the sample firms for the same period. This may be due to the fact that there are many non R&D performing firms in each industry and the average R&D intensity of the industry comes down if these firms are included. On the other hand, for the year 2010 the R&D intensity of the sample firms is very high as compared to the period 2003-2010. Similar findings have been reported for the year 2010 in Global Innovation 1000 study by global management consulting firm Booz & Company (2011). According to this study Companies based in China and India accounted for just 2 per cent of global R&D outlays in 2010 but increased their R&D investment by more than 38 per cent[2]. Companies investing on R&D activities are mainly to compete more effectively in the upturn.

Table-5 presents the average intensities of important variables taken in this study. It is clear that top-50 business houses have higher R&D intensity in both capital account and current account. Average R&D intensities for the period 2003-2010 have lower value than for the year 2010. This clearly shows that R&D intensity is fragmented one and not continuous. In some years the firms invest more than the average on R&D. Foreign business houses has high export intensity as well as import of capital intensity. Higher import of capital goods often substitutes the R&D activities as the technology is already embedded in the capital goods. In such cases firms generally go for minimal R&D activities to localize it. Royalty payment is high both for Top-50 business houses and foreign business houses. This also is likely to discourage R&D activities as technology is purchased. Advertisement intensity of foreign business houses is more than the top-50 business houses. But at the same time investment in outside market which represents outward orientation is higher in case Top-50 business houses than the foreign business houses. In case of profitability top-50 business houses reap higher profitability than rest of the groups taken in this study. It is clear form this table that there are variations in these intensities across different groups.

The study begins with estimating the equation 1 and 2 through ordinary least square methods. However, the results indicated the strong presence of multicollinearity and heteroscedastity problem[3]. The study has solved the problem by using appropriate methods for both the problems. In addition this this, since R&D expenditure and advertisement expenditure are endogenous variable, the study applied two stage least square methods, which is a better suitable model than multiple regression model estimated through OLS. As mentioned there are possibilities of simultaneity in the model between advertisement and R&D, hence the study tested the presence of simultaneity with Hausman (1978) test.

The results of Hausman test for simultaneity reported in table 1 shows that all the residuals are statistically significant, using 't' tests, except the R&D current account for the current period. Therefore, simple OLS may not be the right method to estimate the models. Hence the study focused on the two-stage least square method to estimate the models. While estimating the R&D models with 2SLS method, the estimated Advertisement is taken as an independent variable, which is reported as $\widehat{ADV}$.

Two stage least square regression results are reported in table 2. A total of four different combinations dependent variables were estimated using both current and capital expenditure on R&D by the firm. This allows the flexibilities in the system to be captured and to ensure the robustness of the model.

The results of 2-SLS shows different pattern in different models. The determinants of R&D intensity vary in terms of sign and the values of coefficients except few exceptions. The coefficient of top-50 business house dummy is largely insignificant except in Model-2 which shows that top-50 business house spends more on R&D than others. Large business house dummy is negative in all the four models and significant in three models. This indicates that large business houses have significantly less R&D intensity than the rest. Similarly foreign business houses dummy is negative and significant in all the models indicating significant lower R&D intensity than others. This behavior can be justified for foreign business houses as they normally depend on their parent companies located abroad for technology and hence, requires very less R&D in India. This is also confirmed by Pradhan (2002). The negative signs of the coefficient of large business houses (LBH) could also be the same as these big business houses rely mostly on foreign partners for their technology needs. Hence one can conclude that large business houses and foreign business houses affiliation has negative effect on R&D intensity. Whereas top-50 business house affiliation does ensure higher R&D intensity in selected Indian firms especially during upturn. During upturn economic activities expands and the scope of expansion for the firms from top-50 business houses is high. This also shows that top-50 business houses take risk by

[2] For details see http://www.booz.com/media/uploads/BoozCo-Global-Innovation-1000-2011-Culture-Key.pdf

[3] Results are not reported here due to space consumption and can be obtained upon request.

investing in R&D activities to gain competitive advantage than others.

A firm competing in international markets by exporting and/or investing abroad does affect the R&D intensity. The result shows that export oriented firms represented by export intensity is throughout positive and significant in model-1 and 3. Similarly, the firm which invests in international market tends to spend more on R&D activities. Investment abroad intensity as a proxy to measure global competitiveness (GC) is positive throughout and significant in model-1, 2, 3. This indicates that in the international market R&D activities certainly help the firm to achieve competitiveness.

Import of capital goods is expected to show the negative relationship as technology is embedded in the capital goods and hence in-house R&D requirement is low. The results however are mixed with both positive (Model-2) and negative relationship (Model-1&3) as per the estimated sign of the coefficient. Positive relationship can be justified when there is high adaptation required in the capital goods for the local use. If this is the case then higher R&D expenditure is required. However, as both the results are statistically significant the study could not conclude effectively the impact of import of capital goods on R&D intensity.

Similarly, Royalty payment is expected to lower R&D activities as technology is purchased rather than developed in-house. The coefficients of royalty provide mixed evidence. Some of the coefficients shows negative sign and some are positive; similarly some are statistically significant and few are not. In average R&D models (Model- 1 and 3) the coefficient of royalty intensity is 7.13 and 5.16 which has positive sign and statistically significant at 1 and 5% significance level, but in model-2 it is -1.2 which is negative and statistically significant are 1% significance level. Positive relationship shows royalty to be complementary and hence it increases the R&D intensities whereas a negative relationship indicates it to be substitute.

Similarly past average profitability also shows the mixed results. In average R&D model (Model-1) the coefficient values of -0.483 shows statistically significant negative relationship with R &D, whereas, in current period models (Model-2 and 4) the coefficient values of 2.38 and 2.39 respectively shows statistically significantly positive relationship. Positive relationship indicates that higher past profitability leads to higher R&D intensities. This also means that R&D activities are funded by profitability of the firm. Negative relationship indicates that when profits are falling the firm goes for higher R&D activities.

Advertisement intensity also shows negative relationship in Model-1 and 3 indicating it to be substitute and compete for the budget with R&D activities. But for the year 2010(i.e. model-2,) it shows that both are complementary and move in the same direction.

The results discussed above shows major differences in Model-2 which takes R&D intensity for the year 2010 as the dependent variable. The year 2010 being the year of recovery followed by the recent global recession for major economies, the changes in firms' behavior are quite expected. For example, economic activities increases during recovery which makes the firms to change their behavior accordingly. Top-50 business houses R&D intensities increases, higher import of capital goods leads to higher R&D. Higher royalty payment is discouraging R&D activities, profit is positively contributing to R&D and finally the advertisement becoming complementary to R&D activities. It is worthwhile to mention at this point that for the year 2010 the R&D intensities are quite higher than the average as shown in table-4.

The R^2 and Adjusted R^2 are although low as expected due to the nature of cross section study. For cross section study it is considered to be good. The values of Durbin-Watson test (DW) are close to 2 hence, the study accepted the null hypothesis and concluded that the errors are not serially correlated and hence the model doesn't suffer from autocorrelation problem.

Conclusions

In this study an attempt has been made to identify and analyses various factors that determines R&D intensity in India after reviewing the existing frameworks used in industrial organization and strategic management literatures. The present study along with the determinants of R&D intensity also tries to verify the role played by group affiliation in R&D decision. The sample size of 3165 firms spread across 27 industries has been taken for this study. To capture the behavior of business house affiliation, the classification given by PROWESS database provided by CMIE, Mumbai has been used. The study also checked the simultaneity in the system using Hausman test and found that there is simultaneity between advertisement and R&D intensity. Therefore, empirically it has used two stage least square models to estimate the results.

The result shows that group affiliation as such doesn't ensures higher R&D intensity rather it shows that group affiliated firms on an average having lower R&D intensity than the rest. However top-50 business houses affiliation ensure higher R&D intensity for the year 2010 which also happens to be the year of recovery from downturn. Companies are investing on R&D activities are mainly to compete more effectively in the upturn. The results of average and current period R&D models are different in many cases which suggest that there are variations in R&D determinants. But at the same time outward orientation measured by two variables i.e. export intensity and investment abroad intensity turned out to be consistent throughout and affects positively. It can be concluded that outward orientated firms needs higher R&D to effectively complete in the global market. During recovery period R&D initiatives are funded by past profitability. The year 2010 to be a year of recovery and hence firms R&D behavior is different in this year with higher R&D intensities.

This study is limited in few ways, as mentioned earlier that Indian firms report R&D expenditure only if it is more than one percent of the total turnover which forced the study to ignore many firms with zero R&D figure. The second important limitation is the way group affiliation is reported in Prowess database is not too broad. According to the database there is no strict rule that can be applied to associate a company with a business group. It is neither entirely defined by the concept of promoters stake, nor is it a case of a certain percent of equity ownership with a particular individual or family, nor is it management control. Each of these is important but, none is a fool-proof way of defining ownership control and management. Prowess uses the available data, its intelligence and judgment in associating a company to a business group or any ownership heading in the ownership structure. The classification is thus sometimes tentative. This logical organization of ownership groups encapsulates knowledge of Prowess's understanding of the organization of the business groups in India.

References

1. Asian Family Business Report, (2011) 'Emerging market research institute', Credit Sussie.
2. Bain, J.S. (1951) 'Relation of profit rates to manufacturing industry concentration American manufacturing, 1936-40', *Quarterly Journal of Economics*, Vol. 65, pp. 293- 324.
3. Bandyopadhyay, A. and Das, S. K. (2005) 'The linkage between the firm's financing decisions and real market performance: a panel study of Indian corporate sector', *Journal of Economics and Business*, Vol. 57, No.4, pp 288-316.
4. Barney, J. (1991) 'Firm resources and sustained competitive advantage', *Journal of Management,* Vol.17, No.1 pp. 99 – 120.
5. Barney, J. (2001) 'Is the resource-based view a useful perspective for strategic management research? Yes. *Academy of Management Review,* Vol.26. pp. 41–56.
6. Bell, M. and Scott-Kemmis, D. (1985) 'Report on a study of technology transfer and the accumulation of technological capacity in manufacturing industry in Thailand. Science Policy Research Unit, University of Sussex, Brighton.
7. Borje, J. and Haans, L. (2008) 'Innovations activities explained by firm attributes and location' *Economics of Innovation and New Technology*', Vol. 17, No.6, pp 533-552.
8. Braga, H. and Willmore, L. (1991) 'Technological imports and technological efforts: an analysis of their determinants in Brazilian firms', *The Journal of Industrial Economics*, Vol. 39, No.4, pp. 421-432.
9. Brozen, Y. (1951) 'Invention, innovation, and imitation', *The American Economic Review*, Vol. 41, No.2, pp. 239-257.
10. Caves, R. E. (1971) 'International corporations: the industrial economics of foreign investment' *Economica*, Vol. 38, No.149, pp. 1-27.
11. Caves, R.E. and Porter, M.E. (1977) ' From entry barriers to mobility barriers: conjectural decisions and contrived deterrence to new competition', *The Quarterly Journal of Economics*, Vol.91 ,No.2, pp.241-262a
12. Cohen, W. M., and Klepper, S. (1992) 'The anatomy of industry R&D intensity distributions', *American Economic Review* Vol. 82, No.4, pp.777–99.
13. Desai, A. V. (1985) 'Market structure and technology: Their interdependence in Indian industry', *Research Policy,* Vol. 14, Issue 4, pp. 161-170.
14. Drucker, P. F. (1986) '*The Frontiers of Management: Where Tomorrow's Decisions are Being Shaped Today'* New York: Truman Talley Books/E.D. Dutton
15. Geroski, P., Machin, S. and Reenen, J.V. (1993) 'The profitability of innovating firms', *RAND Journal of Economics*, Vol. 24, No.2, pp.198 – 211.
16. Graham, L. and David P. (2006) 'Strategic group theory: review, examination and application in the UK pharmaceutical industry', *Journal of Management Development*, Vol. 25 Issue. 4, pp.386 – 408.
17. Gujrati, D. (2003), *Basic Econometrics*, McGraw Hills, New York, 3rd edition.
18. Hausman, J. A. (1978) 'Specification tests in econometrics,' *Econometrica*, Vol. 46, No.6, pp. 1251–1271.
19. Hay, A. D. and Morris, D. (1991) '*Industrial Economics and Organization: Theory and Evidence',* Oxford University Press, USA, Revised Edition
20. Hufbauer, G. C. (1970), 'The impact of national characteristics and technology on the commodity composition of trade in manufactured goods', in R. Vernon, (eds)*The Technology Factor in International Trade*, UMI, New York: Columbia, pp 143 – 232.
21. Hunt, M.S. (1972) '*Competition In The Major Home Appliance Industry, 1960-1970'*, Harvard University, Cambridge, MA,
22. Hymer, S. H. (1976) '*The International Operations of National Firms: a Study of Direct Foreign Investment*, MIT Press, Boston, USA
23. Jacobs, M. (1991) '*Short-Term America: The Causes and Cures of Our Business Myopia'* Harvard Business School Press, Boston, MA
24. Jaffe, A.B.(1986) 'Technological opportunity and spillovers of R&D: evidence from firms' patents, profits and market value,' *The American Economic Review* Vol. 76, No. 5. pp. 984-1001.
25. Katrak, H.(1989) 'Imported technologies and R&D in a newly industrializing country: the experience of Indian enterprises', *Journal of Development Economics*, Vol. 31, Issue 1, pp. 123-139.
26. Khanna, T. and Rivkin J.W.(2001) 'Estimating the performance effects of business groups in emerging markets', *Strategic Management Journal*, Vol. 22, Issue 1. pp. 45-74.
27. Kindleberger, C. P. (1969), *American Business Abroad: Six Lectures On Direct Investment',* Yale University Press, New Haven
28. Kotabe, M.s (1990) 'The relationship between offshore sourcing and innovativeness', *Journal of International Business Studies*, Vol. 21, No.4, pp. 623-39.
29. Kumar, N. and Aggarwal, A. (2005) 'Liberalization, outward orientation and in house R&D activity of multinational and local firms: A quantitative exploration for Indian manufacturing', *Research Policy*, Vol. 34, No. 4. Pp.441-460.
30. Kumar, N. and Saqib, M. (1996) 'Firm size, opportunities for adaptation and in-house R&D activity in developing countries: the case of Indian manufacturing', *Research Policy*, Vol. 25, Issue 5, pp. 713-722.
31. Link, A. N. (1983) *'Alternative Sources of Technology: An Analysis of Induced Innovations', Managerial and Decision Economics*, Vol. 4, No. 1,pp. 40-43.
32. Lippmam, S. and Rumelt, R.P.(1982) 'Uncertain imitability: an analysis of inter-firm differences in efficiency under competition', *Bell Journal of Economics*, Vol. 13, No. pp.418 – 38.
33. Mansfield, E. (1963) 'Size of firm, market structure, and innovation', *The Journal of Political Economy*, Vol. 71, No.6, pp.556-576.
34. Mason, E. S. (1939) 'Price and production policies of large scale enterprises', *American Economic Review* Vol. 29,(*Supplement*) pp.61-74.
35. Molen, R.V.D. (2005*) 'Business Groups, Investment, and Firm Value Empirical Studies on India',* Labyrint Publications, The Netherlands
36. Nagesh, K. (1990) 'Mobility barriers and profitability of multinational and local enterprises in Indian manufacturing', *The Journal of Industrial Economics*, Vol. 38, No.4, pp.449 463.
37. Narayanan, K. (1998) 'Technology acquisition, de-regulation and competitiveness: A study of Indian automobile industry', *Research Policy*, Vol. 27, No.pp.215-228.
38. Narayanan, K. (2004) 'Technology acquisition and growth of firms: Indian automobile sector under changing policy regimes', *Economic and Political Weekly*, Vol. 39, Issue 5, pp.461-470.

39. Pearl, J. (2001) 'Intangible investment, tangible results,' *Sloan Management Review*, Vol. 43, No. 3, pp.13-14.
40. Porter, M. E. (1979) "The structure within industries and companies' performance', *Review of Economics and Statistics*, Vol. 61, pp. 602-13.
41. Porter, M. E. (1990) *'Competitive Advantage of Nations*,' The Free Press, New York.
42. Porter, M. E. (1992) '*Capital Choices: Changing the Way America Invests in Industry*. Council on Competitiveness/Harvard Business School, Boston, MA..
43. Pradhan, J.P. (2002) 'Liberalization, firm size and R&D performance: a firm level study of Indian pharmaceutical industry', *Journal of Indian School of Political Economy*, Vol. 14, No. 4, pp. 647–666.
44. Romijn, H. (1996) *'Acquisition of Technological Capability in Small Firms in Developing Countries',* Ph.D. Thesis, Center for Economic Research Tilburg University, Tilburg.
45. Schumpeter, J. A.(1943) '*Capitalism, Socialism and Democracy'* George Allen and Unwin, London.
46. Sea, J. C. and Jaebum, H. (2002) 'How much does the business group matter in Korea? *Strategic Management Journal*, Vol. 23, No.3, pp. 265–274.
47. Siddharthan, N. (1992) 'Transaction costs, technology transfer and in-house R&D: A study of the Indian private corporate sector', *Journal of Economic Behavior and Organization*, Vol. 18, Issue 2, pp. 265-271.
48. Siddharthan, N. S. and Rajan, Y. S. (2002) '*Global Business, Technology and Knowledge Sharing: Lessons for Developing Country Enterprises'* Macmillan India Ltd, Delhi.
49. Siddharthan, N. S. and Pandit, B. L. (1998) 'Liberalisation and investment: behaviour of MNEs and large corporate firms in India', *International Business Review*, Vol. 7, No.5, pp. 535-548.
50. Srivastava, R., Fahey, L. and Christensen, H. K. (2001) 'The resource-based view and marketing: the role of market-based assets in gaining competitive advantage', *Journal of Management*, Vol. 27, No. 6, pp.777-802.
51. Symeonidis, G. (1996) 'Innovation, firm size and market structure: Schumpeterian Hypotheses and some new themes', Organization for Economic Co-operation and Development, OCDE/GD, WP 161, pp. 1-42.
52. Trina, L. A. and Srini S. S. (2003) 'Advertising intensity and R&D intensity: differences across industries and their impact on firm's performance', *International Journal of Business and Economics*, Vol. 2, No. 2, pp.167-176.
53. Wernerfelt, B. (1984) 'A resource-based view of the firm', *Strategic Management Journal*, Vol. 5 pp.71-80.

Table 1 Hausman test for Simultaneity between Adv and R&D

Model	Endogenous Variables	Residual from RFEq-6 (w_i)	Residual from RFEq-5 (v_i)
Model-1	Adv	-1.28 (53.410)*	
	R&D capital account (avg)		6.15 (3.75)*
Model-2	Adv	-4.21 (109.44)*	
	R&D capital account (current)		-83.27(6.56)*
Model-3	Adv	-0.962 (45.31)*	
	R&D current account (average)		5.59(2.43)**
Model-4	Adv	0.27 (57.14)*	
	R&D current account (current)		6.75 (0.63)

The values in parenthesis represent t statistics. *, **, and *** represents significance at 1%, 5% and 10% level

Table 2 Determinants of R&D intensity in Indian Selected firms (2SLS)

Independent Variables	Average R&D Intensity(2003-10)		R&D Intensity of 2010	
	Current Account	Capital Account	Current Account	Capital Account
	Model-3	Model-1	Model-4	Model-2
Constant	0.096 (0.525)	-0.032 (0.213)	3.35 (3.94)*	3.744 (20.16)*
TOP-50 Business Houses in India dummy (Top)	-0.033 (0.099)	-0.469 (1.72)	1.967 (1.26)	2.365 (4.721)*
Large Business Houses in India dummy (LBH)	-0.778 (1.58)	-0.877 (2.20)**	-4.561 (1.99)***	-4.038 (2.56)**
Foreign Business Houses dummy (FBH)	-5.249 (3.12)**	-6.68 (4.90)*	-16.44 (2.10)**	-8.37 (4.66)*
EXPOG	4.346 (2.921)**	5.726 (4.74)*	6.167 (0.891)	0.213 (0.909)
IMPORTCAP	-1.608 (2.01)**	-2.613 (4.02)*	-1.54 (0.415)	1.83 (6.13)*
GC	1.400 (3.019)**	1.73 (4.62)*	2.789 (1.29)	0.833 (5.627)*
ROYALTY	5.16 (2.36)**	7.133 (4.02)*	5.70 (0.561)	-1.02 (4.84)*
Profit	-0.139 (0.618)	-0.438 (2.40)**	2.39 (2.29)**	2.38 (13.64)*
$\widehat{Adv}$	-5.204 (2.24)**	-7.372 (3.92)*	-4.61 (0.429)	2.245 (12.776)*
R^2	0.412	0.388	0.516	0.553
Adjusted R^2	0.411	0.387	0.514	0.552
DW	2.02	2.01	2.02	1.97
Observations	3165	3165	3165	3165

The values in parenthesis represent t statistics. *, **, and *** represents significance at 1%, 5% and 10% level.

Table 3 Industry level average R&D intensity for different Periods

Sl.no	CMIE Classification of Industries	All the firms in the industry for the period 2003-2010	Firms taken for the study period 2003-2009	Firms taken for the study period 2010
1	Alkalies(U)	0.011	2.78	19.13
2	Automobile	0.016	9.50	55.57
3	Automobile ancillaries	0.006	2.24	15.54
4	Cement	0.001	2.23	14.38
5	Cosmetics, toiletries, soaps & detergents	0.003	2.35	13.13
6	Drugs & pharmaceuticals	0.046	2.55	15.56
7	Dyes & pigments	0.004	2.15	13.19
8	Electrical machinery	0.002	4.76	25.85
9	Electronics	0.008	2.57	14.39
10	Ferrous metals	0.001	2.90	17.58
11	Fertilizers	0.001	2.13	13.43
12	Food products	0.001	2.53	15.74
13	Inorganic chemicals	0.002	2.40	14.41
14	Non-electrical machinery	0.009	3.33	19.96
15	Non-ferrous metals	0.000	3.28	15.61
16	Organic chemicals	0.008	2.67	17.60
17	Other chemicals	0.005	2.88	15.44
18	Other non-metallic mineral products	0.001	2.08	12.48
19	Paints & varnishes	0.006	2.11	12.99
20	Pesticides	0.008	2.60	14.61
21	Petroleum products	0.001	3.02	10.32
22	Plastic products	0.002	2.09	13.64
23	Polymers	0.002	3.96	22.81
24	Rubber & rubber products	0.004	2.14	14.11
25	Textiles	0.001	2.26	14.83
26	Tobacco products	0.003	2.25	12.96
27	Tyres & tubes	0.003	2.24	14.63

Source: Compiled from Industry level CMIE data

Table 4 Descriptive Statistics

	Average R&D Capital Account Intensity	R&D Capital Account Intensity	Average R&D Current Account Intensity	R&D Current Account Intensity	Export of goods Intensity (expog)	Import of Capital goods Intensity (import)	Investment Outside India Intensity(GC)	Profitability (prof)	Royalty Intensity (royal)	Advertising Intensity (adv)	Imports of Finished product
	2003-10	2010	2003-10	2010	2003-09	2003-09	2003-09	2003-09	2003-09	2003-09	2003-09
Mean	1.31	7.80	1.54	9.41	0.20	0.13	1.05	0.89	0.32	0.42	0.108
Median	1.01	6.63	1.14	7.59	0.02	0.01	0.79	0.82	0.04	0.09	0.031
Maximum	79.75	353.26	84.08	515.08	27.21	27.75	135.84	110.35	40.71	47.78	22.597
Minimum	0.00010	0.00004	0.00000	0.00000	0.00000	0.0000	0.00000	-0.0165	0.00000	0.00000	-7.431
Std. Dev.	2.75	13.44	3.63	18.58	0.86	0.59	2.97	2.36	1.37	1.89	0.563
Skewness	16.30	17.42	15.23	16.17	21.78	34.59	32.18	34.89	19.69	18.22	18.969
Kurtosis	349.10	386.13	296.64	347.04	618.32	1550.58	1375.09	1513.60	508.26	389.32	834.95
Jarque-Bera	15931859.00	19512044.00	11489759.00	15742044.00	50164662.00	316000000.00	249000000.00	301000000.00	33859882.00	19850689.00	91466048
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Coefff of variation	2.10	1.72	2.36	1.97	4.30	4.54	2.83	2.65	4.28	4.50	5.213
Observations	3164.00	3164.00	3164.00	3164.00	3164.00	3164.00	3164.00	3164.00	3164.00	3164.00	3164.00

Table 5 Average Intensities across Different categories of groups for the period 2003-2010

Business Groups	No. of Firms	R&D Capital Account	R&D Curr. Account	Aveage R&D CapitalAccount	Average R&D Current Account	Export of goods Intensity (expog)	Import of capital goods Intensity (import)	Royalty Intensity (royal)	Advertising Intensity (adv)	Investment outside India Intensity (GC)	Profitability (prof)	Impfinish
		2010	2010	2003-10	2003-10	2003-09	2003-09	2003-09	2003-09	2003-09	2003-09	2003-2009
Top-50 Business Houses	529	12.637	15.74	2.283	2.821	0.325	0.220	0.557	0.677	1.825	1.506	0.17
Foreign Business Houses (FBH)	52	0.042	0.037	0.882	1.088	1.462	0.245	0.704	0.834	0.792	0.883	0.21
Large Business Houses (LBH)	229	0.005	0.080	0.009	0.041	0.160	0.016	0.002	0.008	0.065	0.069	.0027
Others	2354	7.160	8.419	1.114	1.279	0.183	0.153	0.273	0.363	1.103	0.922	0.09