Does M&A matter for R&D? Evidence from the Pharmaceutical Sector in India

Vidhisha Vyas[1] and K. Narayanan[2]

Abstract

It is widely accepted that technological expertise, market know-how, tacit knowledge and quick innovation are crucial corporate assets for facing increased competition. Mergers and acquisitions [M & A] has become a means for firms to acquire, absorb and exploit the knowledge assets of the target firms. The present study investigates the relationship between M&A and innovation activities of pharmaceutical firms (post-M&A R&D intensity) for three post acquisition years. To analyze the impact, appropriate acquirer's characteristics have been drawn from suitable literature dealing with learning and innovation as well as financial economics. Specifically, to understand the impact of M&A on R&D, propensity score analysis is carried out to control for selection of observables. Further, weighted least squares regression has been performed using propensity scores as weights. The findings of the paper suggest that acquisition appear to have a negative impact on R&D intensity of firms in the immediate post-acquisition years. This implies that firms in this sector in India, in the short-run, are using the resources meant for R & D to absorb the know how acquired through M & A. Financial factors captured by leverage also influence negatively the R&D intensity of acquiring firms. Further, while embodied technology imports boost acquiring firms' R&D intensity, disembodied technology imports adversely affect the R&D intensity, implying possible substitution. Relatedness of target and acquiring firms and cross-border M&A, however, enhances the R&D intensity in the post-M&A period.

Key Words: M&A, R&D Intensity, Technological Imports, Propensity Score, WLS regression

JEL Classification: G34, C23, O32

[1] Assistant Professor, Alliance University, Chikkahagade Cross, Chandapura - Anekal Main Road, Anekal, Bangalore. Email- vidhisha.d.vyas@gmail.com

[2] Institute Chair Professor, Department of Humanities and Social Sciences, IIT Bombay. Email knn.iitb@gmail.com

1. Introduction

A growing body of literature argues that mergers and acquisitions [M & A] has become a means for firms to acquire, absorb and exploit the knowledge assets of target firm. Firms with lower innovative capabilities obtain fresh and complementary technologies via acquisition of innovative firms (Barkema and Vermeulen, 1998). However, acquisition can also be an attractive strategy for R&D intensive firms lacking specific knowledge (Hennart and Park, 1993). While market seeking strategies are main driving force for external investments, asset seeking motives are turning out to be more crucial criteria in a firm's decision to undertake M&A (Dalton and Serpio, 1999). It is widely accepted that technological expertise, market know-how, tacit knowledge and quick innovation are crucial corporate assets for facing increased competition (Cantwell and Santangelo, 2002).

The impact of M&A on firm's innovation aspects are supported by several theories. Resource based approach asserts that in the light of rising competition, M&A turns out to be an important vehicle through which firms can augment their asset base by avoiding time consuming internal processes of accumulating innovating resources (Barney, 1991; Teece et. al. 1997). Through acquisitions, firm specific asset with one organization are used more productively in combination with assets of another organization (Anand and Singh, 1997; Capron et. al. 1998). Theory of Industrial organization supports the argument that M&A provide firms an opportunity to reap benefits of economies of scale and scope via cost saving and risk spreading strategies and allow them to carry out multiple R&D projects simultaneously (Henderson and Cockburn, 1996). Theory of learning and innovation suggests that firms can develop their knowledge base by investing in multiple knowledge enhancing projects however during the same period firms can grow their knowledge base by acquiring, absorbing and assimilating the external knowledge bases (Cohen and Levinthal, 1989; Huber 1991). The theory of corporate control however suggest that M&A will hamper innovation activities of firms due to agency problems (Haspeslagh and Jemison, 1991), reduction in managerial commitment for R&D projects, consumption of managerial time and energy in integration process (Hitt et. al. 1991, 1996) and low retention rate of key inventors (Ernst and Vitt, 2000).

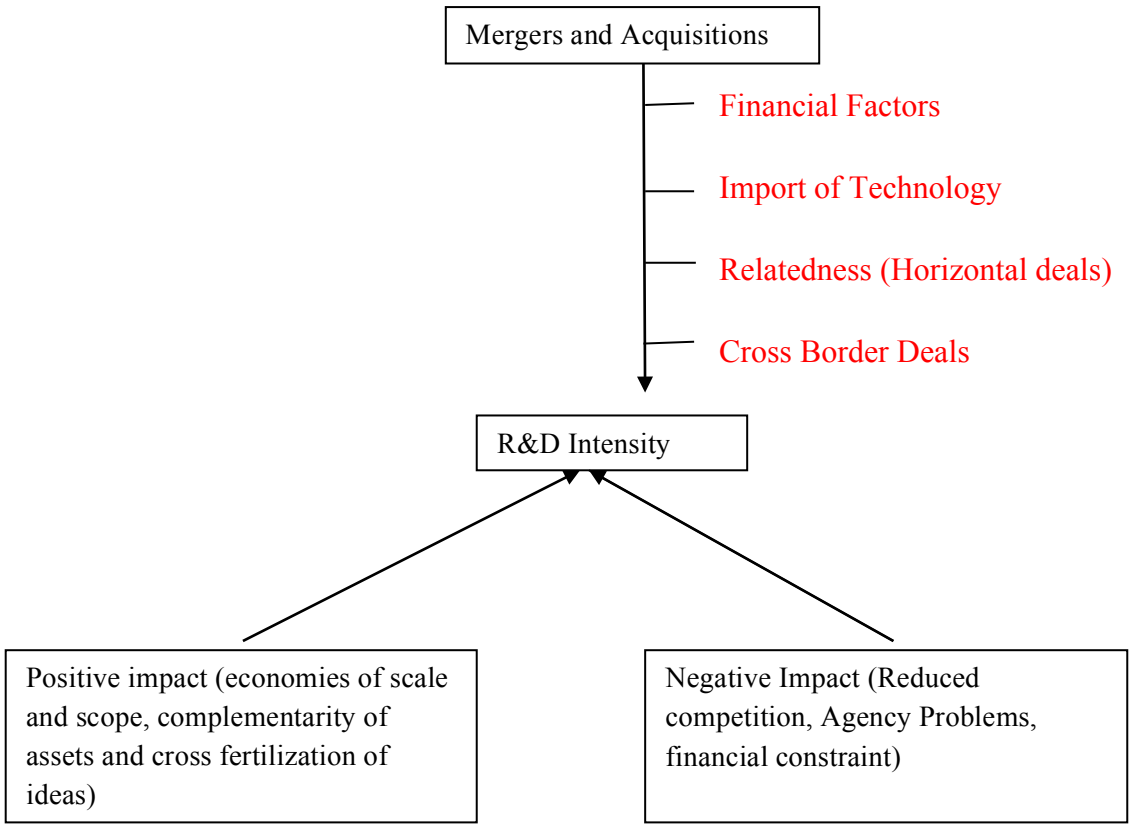
Little academic research has been devoted to study the impact of M&A on innovative performance in emerging economies where M&A is turning out to be an important phenomenon for corporate restructuring and facing global competition. The paper aims to

explore this under-investigated topic and find evidence whether firms in a high technology industry like pharmaceutical have increased R&D intensity following M&A. The reasons that justify the choice of pharmaceutical industry are that it has played a prominent role in the context of Indian M&A wave accounting for some of the big M&As. Second, this industry has high R&D intensity and capacity to innovate, which is clearly the most important factor to set up competition among the firms.

The paper investigates the relationship between M&A and innovation performance of pharmaceutical firms for three post acquisition years in a developing country's scenario. We analyzed the acquirer's innovation performance by studying the impact of M&A on R&D intensity (measured by ratio of R&D expenditure to net sales). We adopted propensity score approach (Rosenbaum and Rubin, 1983) to account for endogeneity of decision to undertake M&A to acquirer's characteristics that are correlated with post- acquisition innovation performance. Propensity score enables us to remove potential endogeneity to observable firm characteristics by creating counterfactual innovation performance (i.e. innovative performance of a firm in situation of non-occurrence of M&A event).

Our analysis also focuses on characteristics of acquirers to explain the impact of M&A outcomes on firm's innovative performances. The appropriate acquirer's characteristics for the analysis have been drawn from learning and innovation approach (Cohen and Levinthal, 1989; Makadok, 2001; Narayanan, 1998) and financial economics approach (Jensen, 1986). These approaches help us to develop the factors which are likely to affect firm's financial and absorptive capacity and help them choose suitable targets and reap benefits of acquisition. We also used deal specific characteristics in the form of control variables like relatedness of acquisition and geographical location of the deals. The important contribution of this paper is that we tried to understand the impact of acquirer's technological imports on in-house R&D efforts in post-acquisition period. In emerging economies technological imports are back bone of technological activity since R&D investments in such economies are largely adaptive in nature.

Diagrammatic Representation for ex-Post Impact of M&A on R&D Intensity



The remaining paper proceeds as follows. Section two presents the theoretical underpinning of the study along with brief review of literature. Section three continues with data and variable description and methodology of the study. Section four presents the empirical analysis and discussion of results. Section five draws the concluding remarks.

2. Theoretical Background

2.1 Ex-poste Impact of M&A on R&D

Acquisition is a means of external technology sourcing which can be complementary, substitutive or both. Innovation in high technology industry has become increasingly a medium to survive in highly competitive markets. As a result large firms frequently face make or buy decision dilemma, especially for quicker innovation (Wagner, 2011). This establishes acquisition as front runner in technology sourcing methods. Research has proved that acquisition strengthens innovation and financial performance of the firms (Irwin et al., 1998, Prabhu et al., 2005, Gantumur and Stephan, 2007) but at the same time other set of research reached the conclusion that M&A reduces R&D efforts of acquiring firms (Hall,

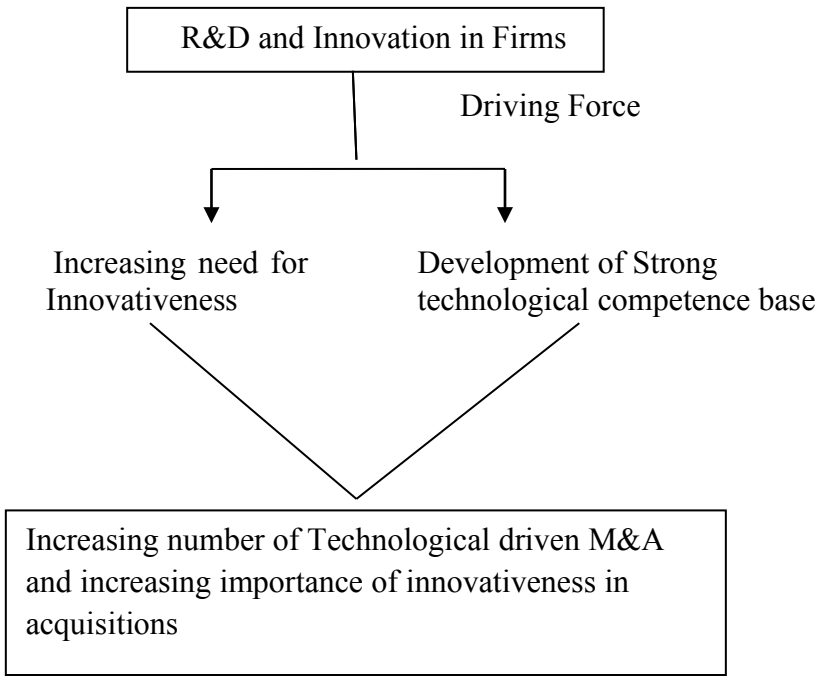
1990; Hitt et. al. 1991). Therefore we tried to answer the question whether acquisition affect the acquirers innovation performance in terms of inputs along with other factors affecting the change in R&D intensity.

At present an increasing number of M&A are driven by motive of acquiring knowledge base which facilitates innovativeness and help in internalizing competencies. The primary objective of innovation driven acquisition is technology based value creation. Technology based value creation is defined as "short and especially long term value creation derived from innovations and the efficient deployment of resources" (Thurner, 2005).

There are two driving forces behind innovation driven acquisitions (Thurner, 2005)

a) Explosion of knowledge creation and shortening of product life cycle in the light of globalization increases need to innovate and create to face the rising competition in the market.
b) Achieving long term innovativeness leading to stable profitable growth.

Such growth is possible by exploiting firms' core competencies. In this circumstance in-house competency development can be time consuming and may not possess all required capabilities. Therefore firms undertake M&A activities as substitutes to internal competencies building R&D capabilities (Bower, 2001).



According to industrial organization literature, M&A are associated with economies of scale and scope of R&D and production as well as internalization of spillovers. R&D restructuring by firms in the light of technological change has led to increase in R&D costs. In such scenario M&A besides seeking new business opportunities also behave as risk spreading tactics which partially balances rising R&D costs. M&A overcome time and cost constraints of R&D activity by acquiring technological and human resources. Economies of scale in R&D spread risks over a portfolio of projects. The rising number of M&A in pharmaceutical sector is a solution to cope with rising R&D costs attached to the production of new drugs and shortening of the pipeline gap. However, in post-acquisition period firms eliminate duplication of R&D inputs leading to reduction in R&D expenditure in short term. M&A are also usually accompanied by large bureaucratic cost causing delay in decision of new R&D projects. Post M&A integration problems and diversion of manager's attention along with financial constraints leads to lower R&D investments.

Secondly, M&A facilitates more promising and high cost R&D programs since there will be greater availability of internal finance. Size benefits also provide easy access to financial markets (Bertrand and Zuniga, 2006). Increased complementarity of technological assets of parties involved in M&A help in improving R&D efficiency. The complementary knowledge acquired by M&A promotes innovation by cross fertilization of ideas between acquirer and target firm's personnel (Bertrand and Zuniga, 2006). Post M&A, firms can reap benefits from economies of scale in non-R&D activities like in output production and distribution. Therefore, according to Schumpeterian hypothesis when R&D investment is spread over larger output a positive effect on R&D investments can be anticipated (Veugelers, 2008).

Moreover, M&A might provide firms with monopoly power. The literature studying the effect of augmented market power on R&D remains inconclusive. On one side monopoly firm invest less in R&D for reaping full profits from existing products; on the other side, entry threats encourage monopolist to invest in R&D to retain its market power (Henderson, 1993). M&A also reduces technology competition reducing incentives to innovate. But industrial organization literature asserts that if technology spillovers are high and M&A allows internalization of these spillovers, high R&D investments can be expected. Conversely, when technology spillovers are not important than negative effect on R&D investment arises (Kamien and Schwartz, 1982).

The relationship between M&A and innovation performance has been investigated by several studies in the past. They focused their analysis on proxies of either R&D inputs or on R&D output (Danzon et al., 2007; Healy et.al. 1992 Ravenscraft and Scherer, 1987 on R&D input and Chakrabarti et.al, 1994; Ahuja and Katila, 2001; Hagedoorn and Duysters, 2002) on R&D output). But there are some studies which offer insight on both R&D input as well as on R&D output simultaneously (Desyllas and Hughes, 2010; Gantumur and Stephan, 2007 on both). Hall (1990) studying the impact of corporate restructuring on industrial research spending concluded a permanent decline in R&D intensity of acquiring firms. Hitt et. al. (1991) examined the acquisition effect on R&D intensity and patent intensity for a sample of 191 US firms and reported significantly negative impact on both the innovation parameters. Even in another qualitative study by Hitt et.al. (1996) they obtained negative impact on R&D intensity and output. Bertrand (2009) studying acquisition of foreign firms by French firms reported an increase in R&D spending in post-acquisition years. While Ornaghi (2009) in his study of 27 large pharmaceutical M&A concluded that mergers do not deliver expected innovative efficiency. Ahuja and Katila (2001) and Cloodt et. al. (2006) reached similar conclusion asserting that M&A boosts R&D output of acquiring firms. Desyllas and Hughes (2010) report in their results negative to positive effect on R&D intensity and negative to neutral effect on R&D productivity.

2.2 Technology imports and development of absorptive capacity

Firms acquire technology externally either through imports (directly in the form of embodied technology in capital goods or at arm- length purchase by paying lump sum fees and royalty payments) or in the form of foreign direct investment or by acquiring technology through M&A events. Following acquisitions in house R&D efforts are required to locate, adapt assimilate, and develop the acquired technology for ready use. Therefore, technology acquisitions need to be complemented with in –house R&D efforts (Narayanan, 1998). Cohen and Levinthal (1989) in their seminal paper explained that in- house R&D is required not only to pursue new product and process innovation but also to assimilate and exploit externally acquired technology. In-house R&D in countries like India, which largely depend on externally acquired technology is basically aimed at adaptation requirement.

Before liberalization and many years in post liberalization era technology transfer or innovation in India were largely in the form of technology imports and these imports facilitates technological paradigm shifts in Indian economy (Narayanan, 1998). Technology

paradigm shift enable firms to operate on different technology frontier. The knowledge base of Indian firms is largely based on technological imports and their adaptability by performing in-house R&D. Under such circumstances, the earlier import of technology can be considered as stock of knowledge for the firms and subsequently develops their absorptive capacity.

Firms with better absorptive capabilities are considered to be more judicious in carrying out M&A activity. Makadok (2001) explained two aspects of absorptive capacity. One is 'resource picking' in which firms with absorptive capacity are better positioned to screen the target and choose appropriate one and at the same time discourage them to choose inappropriate targets. Along with resource picking it is important for firms to exploit the acquired resources which are termed as 'capacity building' by Makadok (2001).

Therefore, external acquisition of technology either through imports or by M&A or by both in the absence of in-house R&D efforts will be inadequate to enhance the innovative performance of firms. Technology imports and technology acquired by M&A can be substitute or complementary to each other. The technology procured via imports can be insufficient and therefore; M&A can provide requisite technology to the firms for developing their innovative capabilities. At the same time technology imports which need to be adapted to Indian requirements can directly be acquired through M&A for ready use. In the light of the above arguments it could be hypothesized that the impact of technology imports of the acquiring firms on R&D intensity remains inconclusive.

2.3 Financial Capacity

Hall (1990) established in her study the link between leverage and reduced R&D expenditure of M&A firms. High leverage does not favor investment in R&D because high leverage entails higher financial risks. In post-acquisition period managers try to minimize volatility by avoiding investments in risky, long horizon payback R&D projects and seek stable source of profit in order to ensure steady cash flow for repaying debts. The assets created by investment in R&D projects are often not re-deployable and seldom transferable. Even the human capital associated is also project specific. Therefore, asset specificity and cash flow argument suggest that leverage taken for M&A will have negative impact on R&D intensity (Hall, 1990).

Firm's R&D capabilities decreases with active acquisition phenomenon. This effect can be attributed to transaction cost involved and to post acquisition integration task which absorbs

managers' time and energy. Focus on acquisition and high level of debt possibly limits managers' discretion either because stock holders and debt providers imposed strict limitations for their funds or managers become risk-averse (Smith and Warner, 1979). Thus, a major decision concerning lower investments in long term projects such that of R&D reduces innovation capabilities of firms. Another argument for post-acquisition reduction in R&D intensity can be attributed to control system implementing R&D strategy. Top executives often look for short term financial control instead of emphasizing on strategic control like R&D (Hitt et. al., 1996). In light of above argument we can hypothesize that high level of leverage at the time of acquisition will adversely impact R&D intensity of acquirers.

Myers and Maljuf (1984) argued that high level of leverage might not impact R&D intensity of acquiring firms adversely because firms first utilize internal cash flow followed by debt and finally when leverage is maximized issue fresh equity for financing acquisitions. Therefore, leverage might or not be a constraint for expenditure on R&D. It may be a case that leverage growth at the time of acquisition could restrict resource allocation to R&D projects. Consequently, high leverage growth of acquirers at the time of acquisition could negatively affect R&D intensity.

2.4 Related Acquisitions (Horizontal M&A)

Horizontal acquisition considers that target and acquirers are operating in similar markets. It is easier to reap synergistic benefits when two firms are operating in one industry (Chakrabarti et.al., 1994; Ahuja and Katila, 2001). In acquisitions, greater the knowledge base concentration of the acquirer, the greater has its expertise in specific technology fields hence it can identify an appropriate related target and could effectively exploit its acquired technology and knowledge (Prabhu et al., 2005).

Hagedoorn and Duysters (2002) studied relationship between M&A and technological performance of computer industry of developed economies. They suggested that related M&A has higher technological performance than unrelated M&A. They explained that better organizational fit and strategic fit between related partners play a crucial role for technical success.

Cassiman et al. (2005) hypothesized that the impact of M&A on R&D process depends upon relatedness (technological or market) of acquirer and target firms. They concluded that

complementary technological fields have positive impact as compared to substitute technological fields but the results are not significant. They also found that market relatedness has negative impact on R&D process when the merging firms are rivals.

Capron (1998) indicated that the efficiency of horizontal acquisitions by bilateral resource redeployment and asset divestiture might enhance firm's technical capabilities and hence stimulates their R&D efforts. This study, therefore, hypothesizes a positive relationship between horizontal M & D and R & D intensity.

2.5 Cross-border Acquisitions

Cross border M&A deals are one of the most important examples of industrial globalization. All the industries have witnessed increasing number of cross-border deals and pharmaceutical sector is no exception to it. Cross border deals generate technological complementarities fostering diffusion of knowledge between the dealing firms. Innovative capabilities are promoted because geographical locations creates heterogeneity between acquiring and target firm which is reflected in terms of labour and capital endowment and economic and regulatory environment of two countries (Bertrand and Zuniga, 2006). On the other hand Kogut and Zander (1992) specifies that cross border deals could lead to higher integration cost. Cultural and geographical distances hamper technology transfer by making communication as well as assimilation of acquired knowledge difficult.

Gugler et.al. (2003) did not find any significant impact of cross border deals on profitability of firms while Markides and Ittner (1994) found cross border deals to be welfare improving for US acquirers. Bertrand and Zuniga (2006) concluded in their study that domestic M&A has enhanced R&D investment in low-technology industries but cross border M&A has insignificant impact on R&D investment in all group of industries. They also asserted that M&A improves performance of host countries. Desyllas and Hughes (2010) also confirmed negative impact of cross border deals on R&D processes of the acquiring firms and attributed this negativity to higher integration and regulatory costs. In the case of Indian Pharmaceutical industry, firms may use cross-border acquisitions as a substitute for technology imports involving tacit information and therefore, acquisitions could positively enhance r & D intensity. In this paper, the types of M & A [horizontal and cross-border] are used more as control variables to account for differences between general M & A and specific ones.

3. Data Variables and Methodology

3.1 Data Description

The study uses pooled cross-sectional data, for the period from 2000 to 2010 for pharmaceutical sector in India. The source of data for M&A deals and firm characteristics is CMIE Prowess database version 4. The number of the firms in each year is 171, with a total of 1360 observations for 8 years. The sample size is approximately 26 percent of total industry. To conduct empirical analysis of M&A effect on R&D intensity for three post acquisition years we used M&A deals which took place till the year 2007. For dependent variable R&D intensity and other firm characteristics like leverage and import of technology we extended data set till the year 2010. The sample firms with acquisition activity carried out 134 M&A during the period of 2000-2007 and where the firms make more than one acquisition in a given year we treat that as only one "acquirer" in that year in the present analysis.

3.2 Variables Description

Dependent Variables

Percentage Change in R&D intensity (R&D) - We tried to measure innovative performance using data on R&D expenditure. We constructed dependent variable in the form of R&D intensity measured by the ratio of R&D expenditure to net sales. By normalizing R&D expenditure by a proxy of firm size we make sure that our variable is not affected by change in size (due to sales) on yearly basis. The percentage change in R&D intensity is calculated from t-1 to t+1, t+2 and t+3 respectively. We also calculated change in R&D intensity from t-1 to the three year average R&D intensity over the period from t+1 to t+3. Several studies has used three post acquisition year window to analyze the impact of M&A on innovation performance as well as on economic performance (Ahuja and Katila, 2001, Bertrand & Zuniga, 2006; Ornaghi, 2009, Desyllas and Hughes, 2010). Post-acquisition three year analysis allows firms to integrate target in effective way up to some extent where it is anticipated that effect of M&A can be significantly visible.

Independent Variables

Mergers & Acquisitions (DMA) - It is a binary variable that takes value one in years when a firm makes at least one acquisition and takes value zero otherwise during the period of 2000-2007.

Import of technology - Import of technology is captured by direct import of capital goods called as embodied technology import or through arm's length by paying royalty and lump sum fees called as disembodied technology imports. We captured embodied technology intensity *(ETI)* by ratio of expenditure on imports of capital goods to net sales. Disembodied technology intensity *(DTI)* variable is computed by ratio of Lump sum, royalty, and technical fees payments in foreign currency to net sales.

Leverage (LEV) - Leverage is measured by the ratio of total borrowing of the firms to the total assets of the firms. We captured leverage growth by measuring the change between the last pre-acquisition year and first post-acquisition year. We assumed that the leverage growth *(LEVG)* for acquirer is caused by debt-financing of M&A deal.

Control Variables

Related Acquisitions (DHMA) - The dummy variable is introduced to discriminate between horizontal and other types of acquisitions. Horizontal acquisition considers that target and acquirers are operating in similar markets. It is easier to reap synergistic benefits when two firms are operating in one industry (Chakrabarti et.al., 1994; Hagedoorn and Duysters, 2002; Ahuja and Katila, 2001). The dummy variable equals one where acquiring and target firm have same 3-digit NIC code and zero otherwise.

Cross-border Acquisitions (DCB) - We employed a dummy variable to discriminate between domestic and cross-border acquisitions. The dummy variable equals one for acquisitions where the target firm is incorporated in foreign country and zero otherwise.

3.3 Methodology

The primary objective of the study is to estimate the effect of M&A on R&D intensity of firms in post M&A period. For each firm i in the sample let $M\&A_i$ be a merger and acquisition indicator that equals one when the firm engages in M&A event and zero

otherwise. Y_{i1} is the change in R&D intensity of M&A participating firm and Y_{i0} is the change in R&D intensity of non- M&A participating firms.

Therefore

$$Y_{i1} = M\&A_i + (1 - M\&A_i)Y_{i0}$$

Accordingly let $E\{Y_{i1}|M\&A_i = 1\}$ and $E\{Y_{i0}|M\&A_i = 0\}$ express average outcomes of innovative performance of M&A and Non M&A firms respectively. The effect we would like to examine is that of M&A on innovative performance. In other words, the difference between expected innovative performance of firms participating in M&A and what would they have experienced if they had not participated in M&A event.

$$\tau = E\{Y_{i1}|M\&A_{it} = 1\} - E\{Y_{i0}|M\&A_{it} = 1\}$$

This is known as expected or average treatment effect on the treated firms (Dehejia and Wahaba, 2002).

Since it is not possible to find out counterfactual evidence of what would have happened had the firm not participated in M&A event, $E\{Y_{i0}|M\&A_{it} = 1\}$ is unobservable. One way to estimate the counterfactual performance is by utilizing information from firms not participating in M&A events i.e. $E\{Y_{i0}|M\&A_i = 0\}$. Therefore the effect can be estimated by difference in expected outcome between the acquiring and non acquiring innovative performance.

$$\tau = E\{Y_{i1}|M\&A_{it} = 1\} - E\{Y_{i0}|M\&A_{it} = 0\}$$

However, observing Y_{i0} for non acquirers will result in biased estimate of acquiring firm's counterfactual performance, if acquirers and non-acquirers firms systematically differ in their firm characteristics (Hirano et. al., 2002). Another cause of biasness could be observed if M&A is endogenous to certain firm characteristics and these characteristics are correlated to post acquisition performance.

To overcome this problem Rosenbaum and Rubin (1983) proposed that a propensity score analysis of similar observational characteristics can be used to create treated and control groups and subsequently post-merger performance effect can be measured using these matched groups.

The propensity score $p(M_i)$ is defined as the probability that firm i will engage in year t conditional upon observed covariates X

$$p(M_{it}) = Pr\left(M_{it} = 1 \middle| X_{i,t-1}\right)$$

If the outcomes (Y_{i1}&Y_{i0}) are independent of the assignment to treated and control firms conditional on observed covariates then classifying firm observations by their propensity score balances the observed covariates X within a subclass with similar $P(M_i)$, the distribution of X is same between treatment and control groups (Rosenbaum and Rubin, 1983). Further the treatment effect of M&A firms with given propensity score is estimated by difference mean outcome of treatment and control group.

$$\tau = E(Y_{it}|P(M_{it}), M_{it} = 1) - E(Y_{i0}|P(M_{it}), M_{it} = 0)$$

But in our analysis we utilized predicted probabilities i.e. propensity score weighting approach suggested by Hirano et. al. (2003) and earlier used by Desyllas and Hughes (2010). They explained that weighting by the inverse of an estimated propensity score will give efficient estimate of average treatment effect which in this study is the acquisition impact on technological performance of acquirers.

Following Desyllas and Hughes (2010) we used the following algorithm for estimating acquisition effect. At first the propensity score is estimated by running logit regression on lagged values of acquirers' economic and innovation characteristics. Use of lagged values take care of endogeneity problem associated with M&A decision and other observable firm characteristics. The dependent variable is a binary variable taking value one and zero depending upon firms' decision to participate in M&A event or not. The explanatory variables include size, leverage, disembodied technology intensity, embodied technology intensity, profit margin, dummy zero R&D, R&D intensity, growth, knowledge base size, R&D productivity measured in t-1 time period. Year dummies are also included {See Appendix A for summary Statistics (Table A1) and logit results (Table B1)}.

In propensity score matching a potential bias can arise from lack of overlapping or mismatching between acquirer and non-acquirer firms which occurs when some treated observations are not comparable to control observations (Heckman et. al., 1997). Common support region condition helps in accounting this possible bias. We compare the maximum and minimum propensity score in acquiring and non-acquiring groups. In this process we

eliminate the observations on acquirers whose propensity score is larger than maximum of non- acquirers and those of non-acquirers whose propensity score is smaller than minimum of acquirers. As a consequence eight observations fall out of our sample which includes seven acquisitions[3].

To check for the adequacy of propensity score the t-test confirms that the mean of observed characteristics after matching are not systematically different for control and treated groups and mean bias has reduced to 2% from 32.5%. (See Diagram in appendix B) Another check whether propensity score balances the observable characteristics between acquirer and non-acquirer group is performed by regressing each covariates on a dummy variable discriminating between M&A and non M&A firm observations and year dummies. The result indicated that the M&A dummy is statistically insignificant. This explains that controlling for propensity score balances the observable characteristics between acquirers and non-acquirers.

In the second stage of the analysis we carried out a weighted least squares regression by regressing percentage change in R&D intensity on a dummy variable that takes value one when firm carries out an acquisition and zero otherwise. The weight of the firm year observation for acquisition dummy equals to one is 1/p and for acquisition dummy equals to zero is 1/1-p. Therefore M&A firms are given more weights when they have lower propensity score while non M&A firms are given more weights when they have high propensity score.

4. Empirical Analysis

4.1 Preliminary Descriptions

The summary statistics presented in table 1 indicates that for all the three post acquisition years M&A firms has lower change in R&D intensity in comparison to control group firms. These statistics provide preliminary suggestion that as depicted by previous literature M&A do not enhance R&D intensity of acquiring firms rather similar firms who have not participated in M&A activity are spending more on R&D projects. M&A undertaking firms has higher leverage and leverage growth in comparison to control group thus, reinforcing the literature findings that leverage and leverage growth has adverse effect on R&D investments of firms. The mean of disembodied technology imports is lower for M&A firms as compared to control group and mean of embodied technology imports is higher for M&A performing firms than control firms.

[3] Ranbaxy Ltd. is the firm which does not fall under common support system and we removed all its observation for 8 years. Due to this there was loss of 7 acquisitions which was conducted by Ranbaxy Ltd. Between 2000-2007.

Table: 1 Summary Statistics

Variable	Mean (S.D.) Full Sample	Mean (S.D.) M&A Firms	Mean (S.D.) Control Sample
$R\&D_{t+1}$	0.24 (1.29)	0.21 (1.16)	0.25 (1.33)
$R\&D_{t+2}$	0.378 (2.40)	0.29 (1.45)	0.40 (2.63)
$R\&D_{t+3}$	0.39 (2.28)	0.28 (1.45)	0.43 (2.49)
R&D average	1.86 (5.72)	2.18 (3.57)	1.75 (6.26)
Leverage	0.32 (.39)	0.35 (0.55)	0.31 (0.32)
Leverage Growth	-0.15 (13.7)	0.42 (3.78)	-0.34 (15.65)
DTI	0.012 (0.06)	0.0006 (0.003)	0.001 (0.006)
ETI	0.0009 (0.005)	0.017(0.075)	0.010 (0.05)
No. of Observations	1350	331	1019

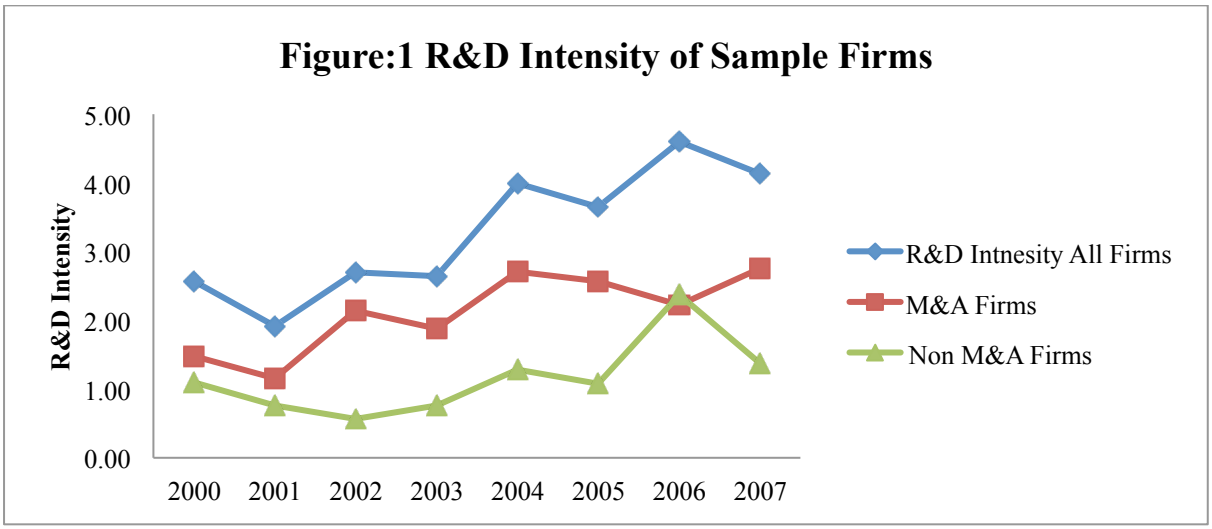
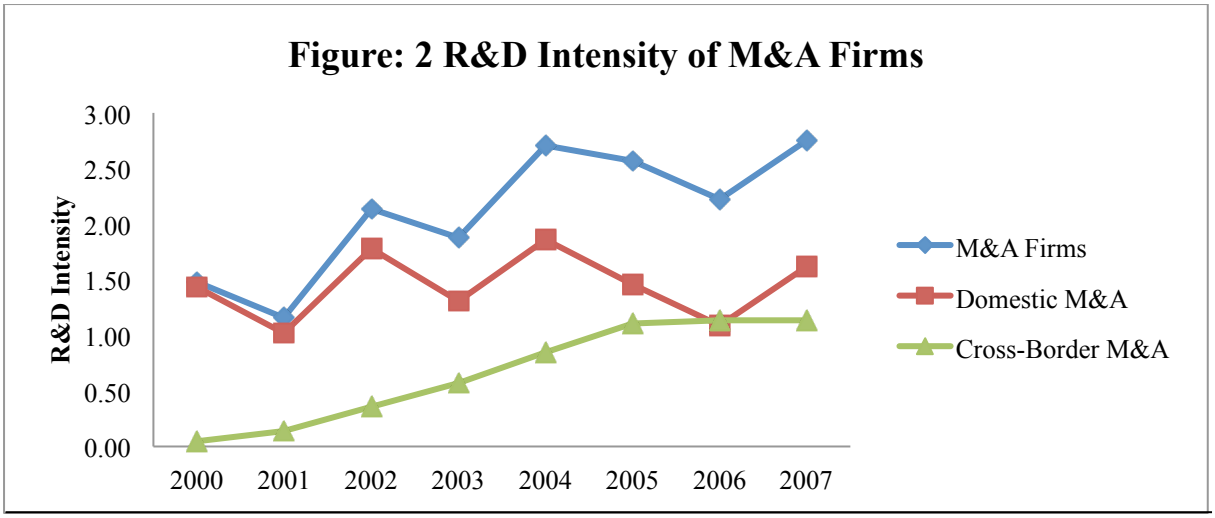


Figure 1 depicts the average R&D intensity of sample firms for the study period of 2000-2007. The graph shows that M&A firms have higher R&D intensity than control group firms. But the change in R&D intensity in post-acquisition year in table 1 is lower for M&A firms indicating possible negative effect of M&A on R&D intensity.

Further when we bifurcated M&A firms in terms of domestic deals and cross border deals figure 2 depicts that R&D intensity of firms going for domestic M&A is higher as compared to cross border M&A. it is observed from figure 2 that R&D intensity of firms going for domestic deals is characterized by fluctuation but those firms who participate in cross border M&A has steady R&D investments.



4.2 Weighted Least Squares Regression Result

4.2.1 The acquisition effect on acquirers R&D intensity

Results of WLS regression for estimating the impact of M&A on change in R&D intensity of acquirers are reported in table 2. The coefficient of acquisition dummy explains the impact of M&A on R&D intensity through WLS regression after controlling for propensity to acquire. The percentage change in R&D intensity from t-1 to t+1, t+2, t+3 periods respectively are regressed on acquisition dummy and year dummies. We also estimated the regression with dependent variable being percentage change of R&D intensity from t-1 to the average R&D intensity of three post-acquisition years.

Focusing on the specification including only acquisition dummy for individual post acquisition years, the results indicate no impact in t+1 and t+2 year on R&D intensity. In t+3 year the results explained significantly negative impact of M&A on R&D intensity relative to non-acquirers (-28 percent). Taking the average of three post acquisition years, it is observed that acquirers experience a significantly lower R&D intensity on average relative to non-acquirers (-94 percent). The result of this study differs from previous studies like Haspeslagh and Jemison (1991) and Desyllas and Hughes (2010) who concluded significant negative effect on R&D intensity in first post-acquisition year and positive impact in third year. These results are similar to those of Ornaghi (2009) and Danzon et. al. (2007). Even the changeover

average of three years also confirms lowering of R&D intensity for M&A firms in comparison to non-M&A firms in post-acquisition years.

Table: 2 Weighted Least Squares regressions: Analysis of Acquisition effect on R&D intensity

% change between t-1and	t+1			t+2		t+3		Average t+1 to t+3
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.142 (1.19)	**0.179** **(1.88)***	0.31 (1.03)	**0.55** **(2.75)*****	**0.55** **(3.85)*****	**0 .54** **(3.44)*****	**2.03** **(4.84)*****	**2.02** **(4.60)*****
DMA	0.013 (0.14)	**0.265** **(1.85)***	0.15 (0.35)	**-0.75** **(-1.79)***	**-0.28** **(-2.37)*****	**-0.60** **(-2.91)*****	**-0.94** **(-3.61)*****	**-1.24** **(-4.29)*****
DCB		-0.036 (-0.28)		5.97 (1.23)		**0.40** **(1.71)***		**1.25** **(3.59)*****
DHMA		-0.226 (-1.58)		0.48 (1.36)		**0.52** **(2.57)*****		**0.57** **(1.67)***
$LEVMA_{t-1}$		**-0.213** **(-7.16)*****		0.68 (0.62)		**-0.602** **(-1.69)***		**-0.15** **(-3.90)*****
$LEVGMA_{t-1}$		0.003 (0.45)		-0.004 (-0.24)		**0.008** **(1.61)***		0.009 (0.38)
$DTIMA_{t-1}$		**-24.85** **(-2.24)****		**-78.63** **(-1.96)****		**-35.05** **(-2.50)*****		**-67.14** **(-2.28)****
$ETIMA_{t-1}$		1.58 (0.63)		-0.82 (-0.33)		**2.32** **(4.89)*****		**9.66** **(1.91)****
LEV_{t-1}		**0.0001** **(3.37)*****		**0.0002** **(4.35)*****		**0.0002** **(6.39)*****		**0.0003** **(6.00)*****
$LEVG_{t-1}$		0-.0030 (-0.37)		0.010 (.53)		-0.008 (-1.57)		-0.006 (-0.26)
DTI_{t-1}		-0.76 (-0.52)		-1.54 (-0.30)		-1.87 (-0.97)		-6.05 (-1.03)
ETI_{t-1}		0.050 (0.09)		-0.34 (-0.37)		-0.60 (-1.46)		0.96 (0.52)
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Observations	1350	1350	1350	1350	1350	1350	1350	1350
F- Statistics	**2.8*****	**42.89*****	**4.02*****	**3.70*****	**4.61*****	**12.76*****	**3.65*****	**12.43*****
R^2	0.042	0.0974	0.029	0.142	0.0673	0.0983	0.017	0.0393

Discussing the impact of M&A on R&D intensity in model including augmented specification, positive and statistically significant effect of acquisition is observed in t+1 year. But statistically significant negative impact is observed for t+2 and t+3 years. Even for the average of three post acquisition years M&A has significant negative impact on acquiring firms' R&D intensity. For the case of Indian pharmaceutical sector the result contradicts the idea that M&A deliver appropriate economies of scale and knowledge synergies.

4.2.2 The technology import effect on acquirers R&D intensity

Analyzing the impact of acquiring firms' technological imports on change in R&D intensity in post-acquisition years, the results suggest separate impact for disembodied technology imports and embodied technology imports. The result for the average of three post acquisition years suggests that disembodied technology imports are negatively impacting the R&D intensity of acquiring firms. On the other hand embodied technology imports boosts post-acquisition R&D intensity. Similar results were obtained for t+1, t+2 and t+3 post-acquisition years. Disembodied technology imports of acquiring firms significantly lower the R&D intensity in all the three consecutive post-acquisition years as well as for average of three years. Embodied technology imports enhance in-house R&D expenditure of acquiring firm but the results are statistically significant only for t+3 year. The results clearly indicate that disembodied technology imports are substitute to M&A acquired technology and reduce R&D investments in post-acquisition years while embodied technology imports are complementary to technology acquired through M&A and encourages in-house R&D expenditure.

4.2.3 Financial capacity of acquirers and R&D intensity

Turning towards the impact of acquirers' financial characteristics, a strong support for negative relationship between acquirers leverage level and post M&A R&D intensity is observed. Statistically significant negative relationship is confirmed between acquirer's leverage level and R&D intensity for t+1, t+3 and the average of three post-acquisition years. These results are similar to that of Hall (1990), Hitt et.al. and (1991) and Hitt et.al.(1996). According to these researchers, high debt level will force firms to provide significant amount of cash flows to debt repayment leaving fewer funds for investment in R&D projects. The result explains that a unit increase in level of leverage in t+1 year after acquisition will decline R&D intensity by 21percent and 15 percent for the average of three post acquisition years. It could be concluded that high leverage is associated with added controls by investors thus; compelling managers to avoid risky investment in R&D projects with long payback periods in post-acquisition period rather than in earlier loosely monitored situations. In contrast, no significant impact of leverage growth at the time of acquisition on R&D intensity is observed. In case of non- acquirers, a significantly positive impact of leverage level on R&D intensity is observed but the coefficient values are very low and stable for all the post-acquisition years. It is likely that non-acquirers might be taking debt to invest in R&D processes and maintain their competitive positions.

4.2.4 Control variables and the impact on R&D intensity

The implication of control variables for R&D intensity is also explored in augmented specification model. The results indicate absence of statistically significant impact of cross border acquisitions on R&D intensity for first two years after acquisitions but found positive and statistically significant effect in third year and also for average of three years. This later effect would indicate that the absorption of new knowledge encourages acquirers to devote greater internal efforts to exploit the technological capabilities of the acquired firms (Martin and Alvarez, 2009). Positive and significant coefficient for time invariant average of three years clearly confirm that cross border acquisitions boost R&D intensity of acquirers more than domestic deals. The relatedness of acquirers and targets is captured by horizontal acquisition dummy. Positive and significant impact of M&A on R&D intensity is observed in third post-acquisition year and also for the average of three post acquisition years. Immediate post acquisition years are consumed in restructuring and integration of target and acquirer firms. Therefore, in later years relatedness effect is prominent as duplication of assets is avoided and complementarity of technological assets of parties involved help in improving R&D efficiency of acquirers.

5. Summary and Conclusions

The paper attempts to address the question whether M & A in Indian pharmaceutical sector improves innovative performance of firms analyzed in terms of R&D intensity. We also examine the role of acquirer's characteristics in the form of absorptive and financial capacity in order to find whether some acquirers are more successful than others. The results over the three post acquisition years and the aggregate of the three years suggest positive to negative effects of acquisitions.

The results of weighted least squares regression analysis suggest that acquisition bring about slight positive impact on R&D intensity in first year (model 2) followed by subsequent negative impact in t+2, t+3 years and in aggregate of three years. This finding is likely to reflect the immediate benefits exploited by acquirer firms from target firms' R&D capabilities. But the subsequent years reveal the influence of bureaucratic hurdles, restructuring cost, integration issues and disruption of established organizational and R&D routines in both target and acquirer firms causing depressing effects on R&D intensity (Ranft amd Lord, 2002). We found in the study that the magnitude of negative effect on R&D

intensity of acquiring firm has slightly diminished over time. As explained by Desyllas and Hughes (2010) the use of propensity score has adjusted estimation of the causal acquisition effect on R&D intensity and eliminated the potential downward bias.

Focusing on the role of acquirer's financial capacity we find that as suggested by earlier studies (Miller, 1990), level of leverage matters for the acquisition effect on R&D. Our results confirm that leverage level tends to impact negatively the R&D intensity of acquiring firms but leverage growth at the time of acquisition is not having any significant effect on R&D intensity. The lag of leverage level suggests the possible debt financing of M&A. These results are similar to that of Hall (1990) but they differ from those of Desyllas and Hughes (2010). The huge amount of leverage disables acquiring firms to afford the necessary post acquisition R&D investments.

Our results focusing on absorptive capacity of acquirer suggest that some acquirers are in a superior position to carry out acquisitions due to their enhanced absorptive capacity [measured by size of acquirer's technological knowledge base represented by technological imports in this study]. R&D intensity is differently affected by technological imports of acquirers. Disembodied technology affects negatively the R&D intensity but embodied technology has significantly positive impact on R&D intensity of acquirers. M&A allows acquiring firms to acquire tacit knowledge thus lowering the need of disembodied technology imports. It is observed that embodied technology imports is complementary to technology acquired via M&A and boosts in-house R&D expenditure.

In case of related acquisitions we find neutral effect in first two post acquisition years but significantly positive impact in third post acquisition year as well as for average of three years. Integration of two firms takes time therefore; results of cross fertilization of common but not similar ideas and resource deployment between two firms can be visible in later years of acquisitions. Interrelatedness also promotes technological complementarities and closeness of ideas which lead to more potential knowledge spill-over thus, promoting enhanced R&D investments. Cross borders deals also affect positively the R&D intensity in later years of acquisition. Cross border deals can generate distinct complementarity creating knowledge transfer across boundaries. The heterogeneity of M&A partners help firms in shaping their innovative capabilities (Bertrand and Zuniga, 2006). Geographical distances and different enterprise culture makes assimilation and application of technology time consuming therefore, synergies could be realized in third post acquisition year in the present paper.

Firms can opt for technology acquisition through imports or by forming strategic alliances, over and above their in-house R & D efforts, in order to revitalize their existing knowledge base. They can also try to overcome the inertia and technological exhaustion occurred through current exploitation of existing knowledge base (Vermeulen and Barkema, 2001) through imports or acquisitions of technologically active entities [other firms or R & D laboratories]. Number of firms based in India is trying to use these options over the last one decade, especially in the Pharmaceutical sector. The R & D intensity of firms in the Pharmaceutical sector has also been relatively higher than that of firms in other sectors. The possible positive impact of M & A on their in-house technological efforts appears to take longer time to materialize. A thorough investigation over a longer period of time is, therefore, recommended before drawing firmer conclusions. However, in the light of our results we suggest that, to reap the benefits of technology acquisition, integration process with those acquired or merged should be carried out carefully and effectively.

References

Ahuja, G., Katila, R., 2001. Technological acquisitions and the innovation performance of acquiring firms: a longitudinal study. ***Strategic Management Journal*** 22 (3), 197–220.

Anand, J., Singh, H., 1997. Asset redeployment, acquisitions, and corporate strategy in declining industries. ***Strategic Management Journal*** 18 (Special Issue), 99-118.

Barkema, H.G. and Vermeulen, F., 1998. International expansion through start-up or acquisition: a learning perspective. ***Academy of Management Journal*** 41 (1), 7-26.

Barney, J.B., 1991. Firm resources and sustained competitive advantage. ***Journal of Management*** 17 (1), 99–120.

Bertrand, O., 2009. Effect of foreign acquisition on R&D activity: Evidence from firm level data of France. ***Research policy***, 38 (6), 1021-1031.

Bertrand, O. and Zuniga, P., 2006. R&D and M&A: are cross-border M&As different? An investigation of OECD countries. ***International Journal of Industrial Organization***, 24(2), 401-423.

Bower, J.L., 2001. Not all M&As are alike- and that matters. ***Harvard Business Review***.

Capron, L., Mitchell, W., 1998. Bilateral resource redeployment and capabilities improvement following horizontal acquisitions. ***Industrial and Corporate Change*** 7 (3), 453–484.

Cantwell, J. And G. Santangelo (2002). M&As and the global strategies of TNCs. ***The Developing Economies*** 40, 400-434.

Cassiman, B., Colombo, M., Garonne, P., and Veugelers, R., 2005. The impact of M&A on the R&D process - An empirical analysis of the role of technological and market relatedness. ***Research Policy***, 34(2), 195−220.

Chakrabarti, A., Hauschildt, J., Suverkrup, C., 1994. Does it pay to acquire technological firms? ***R&D Management*** 24 (1), 47–56.

Cloodt, M., Hagedoorn, J., Van Kranenburg, H., 2006. Mergers and acquisitions: their effect on the innovative performance of companies in high-tech industries. ***Research Policy*** 35 (5), 642–654.

Cohen, W.M., Levinthal, D.A., 1989. Innovation and learning: the two faces of R&D. ***The Economic Journal*** 99 (397), 569–596.

Dalton, D.H. and Serpio M.G., 1999. Globalizing industrial research and development. U.S. Department of Commerce, Office of Technology Policy. Washington DC.

Danzon, P.M., Epstein, A., Nicholson, S., 2007. Mergers and acquisitions in the pharmaceutical and biotech industries. ***Managerial and Decision Economics*** 28 (4–5), 307–328.

Dehejia, R.H. and Wahba, S., 2002. Propensity score matching methods for non-experimental causal studies. ***The Review of Economics and Statistics***, 84(1), 151-161.

Desyllas, P. and Hughes, A., 2010. Do high technology acquirers become more innovative? ***Research Policy***, 39(8), 1105-1121.

Ernst, H., Vitt, J., 2000. The influence of corporate acquisitions on the behaviour of key inventors. ***R&D Management*** 30 (2), 105–119.

Gantumur, T. and Stephan, A., 2007. Mergers & Acquisitions and Innovation Performance in the Telecommunications Equipment Industry. Electronic Working Paper Series, CESIS, no.111.

Gugler, K., Mueller,D.C.,Yurtoglu,B.B. andZulehner,C., 2003. The effects of mergers: an international comparison. ***International Journal of Industrial Organization***. 21(5), 625-653.

Hagedoorn, J., Duysters, G., 2002. The effect of mergers and acquisitions on the technological performance of companies in a high-tech environment. Technology Analysis ***Strategic Management*** 14 (1), 67–85.

Hall, B.H., 1990. The impact of corporate restructuring on industrial research and development. ***Brookings Papers on Economic Activity***, Special issue on Microeconomics.

Haspeslagh, P.C., Jemison, D.B., 1991. Managing Acquisitions: Creating Value Through Corporate Renewal. Free Press, New York.

Healy, P.M., Palepu, K.G., Ruback, R.S., 1992. Does corporate performance improve after mergers? ***Journal of Financial Economics*** 31 (2), 135–176.

Heckman, J., Ichimura, H., Todd, P., 1997. Matching as an econometric evaluation estimator: evidence from evaluating a job training programme. ***Review of Economic Studies*** 64 (4), 605–654.

Henderson, R., Cockburn, I., 1996. Scale, scope and spillovers: the determinants of research productivity in drug discovery. ***Rand Journal of Economics*** 27 (1), 32–59.

Hennart, J.F. and Y. R. Park, 1993. Greenfield vs. acquisitions: the strategies of Japanese investors in United States. ***Management Science*** 39, 1054-1070.

Hirano, K., Imbens, G.W., Ridder, G., 2003. Efficient estimation of average treatment effects using the estimated propensity score. ***Econometrica*** 71 (4), 1161–1189.

Hitt, M., Hoskisson, R., Ireland, R.D., Harrison, J., 1991. Are acquisitions a poison pill for innovation? ***Academy of Management Journal*** 34 (3), 693–706.

Hitt, M., Hoskisson, R., Johnson, R.A., Moesel, D.D., 1996. The market for corporate control and firm innovation. ***Academy of Management Journal*** 39 (5), 1084–1119.

Huber, G.P., 1991. Organization learning: The contribution processes and the literatures. ***Organization Science*** 2 (1), 88-115.

Jensen, M.C., 1986. Agency costs of free cash flow, corporate finance and takeovers. ***American Economic Review***, 76(2), 323–329.

Kamien, M.I. and Schwartz, N.L. 1982. Market Structure and Innovation, Cambridge U.K.: Cambridege University Press.

Kogut, B. and Zander, U., 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. ***Organization Science***, 3(3), 383–397.

Makadok, R., 2001.Towarda synthesis of the resource-based and dynamic-capability views of rent creation. ***Strategic Management Journal*** 22 (5), 387–401.

Markides C. M. and Ittner, C. D., 1994. Shareholder benefits from corporate international diversification: evidence from US international acquisitions. ***Journal of International Business Studies***, 25(2), 343-366.

Martin, R. And Alvarez, I., 2009. Technological effects of M&As in Spanish manufacturing. ***Industrial and Corporate Change*** 18(4), 761-784.

Miller, R.B., 1990. Do merger and acquisitions hurt R&D? ***Research Technology Management*** March–April, 11–14.

Myers, S.C., Maljuf, N.S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. ***Journal of Financial Economics*** 13 (2), 187–221.

Narayanan, K. 1998. Technology acquisition, de-regulation and competitiveness: a study of Indian automobile industry. ***Research Policy***, 27 (2), 215-228.

Ornaghi, C., 2009. Mergers and innovation in big pharma. ***International Journal of Industrial Organization*** 27 (1), 70–79.

Prabhu, J.C., Chandy, R.K., Ellis, M., 2005. The impact of acquisitions on innovation: poison pill, placebo, or tonic? ***Journal of Marketing*** 69 (1), 114–130.

Ranft, A.L., Lord, M.D., 2002. Acquiringnewtechnologies and capabilities: a grounded model of acquisition implementation. ***Organization Science*** 13 (4), 420–441.

Ravenscraft, D.J., Scherer, F.M., 1987. Mergers, Sell-offs and Economic Efficiency. Brookings Institution, Washington.

Rosenbaum, P.R., Rubin, D.B., 1983. The central role of the propensity score in observational studies for causal effects. ***Biometrika*** 70 (1), 41–55.

Smith, C.L., Warner, J.B., 1979. Bankruptcy, secured debt, and optimal capital structure: A comment. ***Journal of Finance*** 34 (1), 247–251.

Teece, D., Pisano, G.P., Shuen, A., 1997. Dynamic capabilities and strategic management. ***Strategic Management Journal*** 18 (7), 509–533.

Thurner, V.B. 2005. Mastering the acquirer's acquisition dilemma: knowledge sourcing through corporate acquisitions. Palgrave Macmillan, New York.

Vermeulen, F., Barkema, H., 2001. Learning through acquisitions. ***Academy of Management Journal*** 44 (3), 457–476.

Veugelers, R., 2008. Literature review in Mergers & acquisitions: The innovation impact. Edited by Bruno Cassiman and Massimo G. Colombo. Edward Elgar, USA.

Wagner, M. 2011. Acquisition as a means for external technology sourcing: Complementary, substitutive or both? ***Journal of Engineering and Technology Management*** 28, 283–299.

Appendix:

Table A1: Descriptive Statistics

	Variables	Mean	S.D.	1	2	3	4	5	6	7	8
1	SIZE	5.81	2.11	1							
2	Disembodied Technology Intensity	0.001	0.008	-0.04	1						
3	Leverage	-3.06	127.5	0.07	0.003	1					
4	Embodied Technology Intensity	0.010	0.05	0.04	-0.02	0.005	1				
5	Profit Margin	0.20	10.90	0.007	-0.001	-0.20	-0.003	1			
6	Dummy Zero R&D	0.51	0.49	-0.56	0.04	-0.02	-0.07	0.002	1		
7	R&D Intensity	0.020	0.12	0.01	-0.01	0.004	0.49	0.002	-0.17	1	
8	Growth	-0.84	29.65	0.06	0.005	0.0003	0.009	-0.06	-0.04	0.01	1

Table A2: Logistic regression for estimating the propensity score of acquisition (Dependent Variable = Acquisition $_t$

Variables	**Coefficient Estimates**
Constant	-5.44 (-8.25)***
SIZE	0.59 (7.39)***
DTI	-51.42 (-1.68)*
LEV	-0.00009(-0.01)
ETI	1.43 (0.62)
PROF	-0.015 (-0.15)
DZERO R&D	-0.79 (-2.74)***
RDI	0.91 (1.30)
GROWTH	0.0005 (0.06)
Time Dummies	Yes
No. of Observations	1360
L R χ^2 (15)	185.19***
Log Likelihood	-345.10
Pseudo R^2	0.2116

Figure A 1: Reduction of Mean Bias after matching