Proximity to industry rivals and firms' R&D attributable performance

Deven Bathia[a], Shafaq Malik[b], Gulnur Muradoglu[c]

Abstract

R&D intensity has substantial value relevance for firms as established by many studies, but do firms' proximity to its rival firms affect its R&D attributable performance? This study intends to investigate this in light of firm's geographical, technological and innovation proximity with its industry counterparts by studying a data sample of firms from NYSE, AMEX and NASDAQ, headquartered in US, from 1975 to 2016. Study has found a strong evidence of impact of technological proximity of firm to its rivals on its R&D attributable performance, where firms that are technologically distant from rivals show higher firm performance attributed to its R&D efforts as opposed to the firms at technological core of the industry. Findings are in line with our hypothesis, that firms technologically distant have a competitive advantage over firms which are similar to rivals in their operations. While geographical proximity of the firms reveal a positive interaction of R&D intensity and presence of rival firms in close proximity, supporting our hypothesis based on R&D performance appreciation due to increased chances of firms' benefitting from knowledge spillover from presence of competing firms in closer proximity. Innovation proximity which indicates firms' closeness to industry in R&D efforts itself is found to hold a significant relationship, firms closer to industry mean in their R&D efforts perform better as compared to firms which are distant from industry counterparts. This is the first study to knowledge that has explored proximity in these three dimensions in connection to R&D performance and results show a strong and compelling evidence on impact proximity to rival firms can bring on R&D attributable performance.

[a] School of Business and Management, Queen Mary University of London, UK
Email: d.bathia@qmul.ac.uk
[b] Corresponding Author, School of Business and Management, Queen Mary University of London, UK
Email: shafaq.malik@qmul.ac.uk / shafaqmalik1@gmail.com
[c] School of Business and Management, Queen Mary University of London, UK
Email: y.g.muradoglu@qmul.ac.uk

1. Introduction

Existing literature on research and development (R&D) strongly support the relevance of R&D in firms' financial parameters from future earnings, earnings volatility, market returns to financing decisions (Eberhart, Maxwell, and Siddique, 2004, 2008; Hsu, 2009; Aw, Roberts and Xu, 2011; Ciftcy and Cready 2011, Hirschey, Skiba and Wintoki 2012; Hirshliefer, Hsu and Li, 2013; Liu and Wong, 2015; Gu 2016). Further studies explored firm specific factors including size (Ciftci and Cready, 2011), financial constraints (Li, 2011), corporate governance (Chung, Wright and Kedia, 2003) and industry specific factor of product market competition (Gu, 2016) to explore how these factors may moderate the R&D attributable firm performance. In this analysis we extend these lines of research by assessing how the firm's proximity to rival firms may affect the R&D attributable firm performance by capturing proximity in three different dimensions including technological proximity, geographical proximity and innovation proximity. Technological proximity shows the operational similarity of firm by measuring whether the firm is at technological core or fringe of industry, geographical proximity measures how geographically close or distant firms is located from its industry counterpart, while innovation proximity measures how far or distant firm is in its innovation efforts compared to its industry counterparts.

Proximity to rival firms may expose firm to both opportunities and competitive disadvantages depending on the parameter. Geographical proximity of a firm to its rival firms may enhance the opportunities of voluntary and involuntary knowledge spillover as studies show evidence of geographic spill overs (Orlando, 2004) and also a geographic match between citing and cited patents (Henderson, 1993). Though knowledge spillovers are not restricted to industry but they are more likely to occur within industry (Jaffe and Trajtenberg, 1999; Orlando, 2004), so I propose that geographical proximity to rival firms would affect the outcomes related to R&D efforts of the firms either formally as a result of interactive learning and knowledge development or informally through labour mobility

and social interactions. These spillovers can play an important role in innovation efforts of firms leading them to improve their R&D attributable performance.

Firms at technological core of their industries may bring in competitive disadvantage for the firms as a result of interdependence of growth opportunities (Haushalter et al. 2007). Gu (2016) argued that successful completion of an R&D project by a firm, leads to value loss for other companies due to losing prospective cash flows associated with the investment and irreversible R&D costs. So firms having similar nature of operations tend to invest in similar nature of R&D investments, resulting into loss of investment or sharing benefits of the investment. So firms more similar to rival firms in their operations face higher competition in terms of exploiting innovation opportunities and are at higher probability of sharing benefits of their R&D efforts with other firms compared to firms that are distinct in operations from industry counterparts.

While exploring impact of firms' proximity to industry counterparts, Innovation proximity could be an important factor that may capture firm's relative position in the industry in innovation competition. R&D intensity where itself is influential parameter, firms' R&D spending relative to industry counterparts may be a substantial moderating factor considering heterogeneous nature of R&D spending across different industries and its vitality in firm survival. Tobacco industry on average spends 0.73% of their sales revenue annually on R&D compared to 18% by Pharmaceutical industry but survival dynamics and reliance on innovation is different for both industries[4]. So I also took into account innovation proximity as intra industry parameter to capture R&D attributable performance.

There is a limited number of studies that took into account inter industry and intra industry parameters to explore their influence on R&D performance and market returns. Gu (2016) studied the impact of inter industry parameter of product market competition in interaction with R&D intensity to explore their impact on expected returns. Furthermore, there is some work carried out on role of geographical proximity focussed on knowledge spillovers (Jaffe, Trajtenberg, & Henderson, 1993;

---

[4] Figures are based on study sample

Audretsch and Maryann P. Feldman, 1996; Orlando, 2004; Kerr and8, 2015) but none of the studies has directly explored the impact of geographical proximity in relation to R&D intensity on firm performance. Orlando (2004) investigates the role of R&D stock of geographically and technologically near and distant firms in firms' production function to capture spillover effect, however the study is focussed on spillover effect. This study is different from Orlando (2004) in many ways; firstly the objective of their study is to measure spillovers resulting through R&D of other firms geographically and technologically near or distant, while this study is focused on direct impact of proximity on firm's R&D performance and stock returns. Secondly, Orlando has worked on only one sector (SIC 35), the Industrial and Commercial Machinery and Computer Equipment Sector, however this study is spanned on all listed firms, excluding financial and utility sectors. Thirdly, this study uses different dimension for technological proximity; where Orlando uses firms' presence in narrowly or broadly defined SIC sectors as an indicator of technological proximity while this study is using technological proximity in context of operational similarity of the firms, as study is analysing intra industry proximity measures in closely defined industries so use of industry definition to measure technological proximity is of no importance.

In these perspectives it is the first study to knowledge to explore the importance of firm's proximity to industry counterparts on R&D attributable performance in given three parameters. This study aims to fill this gap by presenting an analysis of firms traded on NYSE, NASDAQ and AMEX from 1975 to 2016. I have found that technological proximity significantly affects the R&D attributable performance where 1% increase in R&D intensity increase the profit margins by 1.02% for firms which are technologically closer to industry, but increase by 1.37% for technologically distant firms. There is a significant positive interaction effect of geographical proximity and R&D intensity on firm performance showing increase in profitability with increase in R&D intensity is higher for geographically near firms (1.37%) compared to geographically distant firms (0.91%). And I also found a significant negative interaction effect of innovation proximity and R&D intensity on performance, inferring firms closer to industry in innovation efforts result into higher R&D attributable earnings compared to distant firms.

2. Literature Review and Hypothesis development

This sections reviews the literature relevant to each of the proximity measure including technological proximity, geographical proximity and innovation proximity, leading to construction of hypotheses for our study.

2.1 Technological Proximity, R&D intensity and firm performance

Technological proximity shows the operational similarity of firm to its rival firms and indicates whether the firm is at technological core or fringe of its industry. Firms' interdependence in terms of investment opportunities is greater when firm is more similar in technology to its industry counterparts. Haushalter et al. (2007) argue that "when a firm cannot fully take advantage of its investment opportunities, it risks losing these opportunities and market share to rivals". They elaborate that firms with similar nature of operations share large proportion of growth opportunities within industry which leads to create predatory behaviour in rival firms and ultimately leads towards firms' inability to fully invest or take advantage of these investment opportunities. We propose that benefits related to R&D investments are particularly affected by operational similarity of firm to its industry counterparts. The more similar the firm is to its rival firms in terms of nature of operations, there are more chances for the firm to invest in similar nature of R&D opportunities, resulting into more chances for firms to abandon or postpone their R&D initiative if one or the other firm leads in successfully completing the R&D venture or would ultimately lead the firms to share the benefits of their investments.

Gu (2016) argue that successful completion of an R&D project by a firm, leads to value loss for other companies due to losing prospective cash flows associated with the investment and irreversible R&D costs. The interdependence in terms of competing for similar nature of investments make firms at technological core of industry to be more vulnerable to the risk of losing on R&D investment compared to firms whose operations are less similar to their industry counterparts. So being operationally distant from industry players may arise distinct investment opportunities leading to create competitive

advantage for technologically distant firms. Thus, the study hypothesize that firms which are technologically distant from industry counterparts have a competitive edge on firms technologically at core of industry and this competitive advantage lead technologically distant firms to reap more benefits on their R&D investments compared to technologically near firms.

H1: Technological distance of a firm to rival firms in its industry positively affects the R&D attributable performance

Impact on R&D attributable performance is captured through the interaction effect of firm's R&D and firm's technological proximity to its industry counterparts and study presumes a positive interaction effect as lower value of technological proximity means firm is closer in nature of operation to average industry players and compete for same investment opportunities resulting into higher chances on losing on R&D efforts compared to a firm which is technological distant. Study follows Haushalter, Klasa & Maxwell (2007) methodology which adapts MacKay and Phillips (2005) basic measure of capital to labour ratio to determine whether a firm is at the technological core or fringe of its industry.

2.2   Geographical Proximity, R&D intensity and firm performance

Geographical proximity of a firm to its industry counterparts may affect its R&D performance, predominantly through knowledge spillover. There has been an extensive debate on geographical agglomeration of industries, where several advantages of localization of industries have been highlighted (add studies ref). Audretsch and Feldman (1996) claim that if the ability to receive knowledge spillovers is influenced by distance from the knowledge source, then geographic concentration should be observed.

Capello (2009) argue that localization of industries leads to cost reductions based on economies of specialization, labour market economies and assists knowledge spillover. Discussing knowledge spillover effect, Capello (2009) argues that geographic concentration of industries facilitates interactive learning, knowledge development and innovation. Henderson (1993) find that there exists a geographic match between a citing and cited patent across firms. Their study shows that knowledge

spillover is more likely to occur within country boundaries and likelihood increases as boundaries become narrower from country to state and further to metropolitan area.

Knowledge spillover may be involuntary through labour mobility and social interactions (Boari and Lipparini, 1999; Albino et al, 1999; Maskel 2001). Chen (2013) considered workers mobility as a determinant of knowledge spillover and Freedman (2008) find that individuals may be more willing to take a job with an opportunity available in close location enabling knowledge spillover. Silva and McComb (2012) also argue that Workers are able to acquire employment market information through their localized network at relatively low cost and are able to use existing personal relationships to advantage in competition for employment. So knowledge spillover may be localized geographically because of knowledge workers' increased chances of mobility within narrower regional boundaries.

Though knowledge spillovers are not restricted to industry but they are more likely to occur within industry (Jaffe and Trajtenberg, 1999; Orlando, 2004). While studying the spillovers within and across industries, Orlanod (2004) finds that spillovers are more among firms within narrowly defined SIC four-digit industries rather than broadly defined industry boundaries. Jaffe and Trajtenberg (1999) also find that citations in the same technological class are localized. Thus knowledge spill over is more likely to occur within industry and within close geographical boundaries. Given these augments, it can be assumed that if a firm is in close geographical proximity to its competitor firms in industry then there are more chances to benefit from knowledge spillovers within industry than a firm which is geographically distant.

Where geographical proximity may bring opportunities for firm, it may also result into involuntary knowledge spillovers, Differentiating the impact of incoming and outgoing spill overs, Czarnitzki and Kraft (2012) argue that while a firm may benefit from the incoming information on successful R&D of other companies but a high probability of information leakage in an industry has negative affect on profitability. Based on their argument we may say that as R&D ventures take time to materialize, so information outflows would mean losing important information to rivals, which may result into

inability of firm to reap exclusive benefit of their R&D efforts. Exploring the adverse impact of spillovers, Chen, Chen, Liang and Wand (2013) find that outgoing spillovers tend the firms to underinvest in R&D. Furthermore, Silva and McComb (2012) report that greater concentration of firms in the same industry in very close proximity increases the mortality rate while industry concentration over larger distances reduces mortality rates. Study hypothesizes that geographical proximity to industry counterparts enhances the opportunities for voluntary and involuntary knowledge spillovers leading to improve firm's R&D attributable performance. Thus, second hypothesis of the study states:

H2: Geographical proximity of a firm to rival firms in its industry positively affect the R&D attributable performance

Impact on R&D attributable performance is captured through the interaction effect of firm's R&D and firm's geographical proximity to its industry counterparts. So study assumes that firms benefit through the knowledge spillover effect due to being in close proximity to its fellow industry firms (based on arguments of Audretsch and Feldman, 1996; Jaffe, Trajtenberg, and Henderson, 1993; Capello 2009), thus resulting into more productive R&D and enhanced R&D attributable performance compared to distant firms which are less able to cultivate industrial spillovers, thus generating a positive interaction effect. To compute the geographical proximity, a proximity score based on the distance of the firm from its rival firms will be computed using data on latitude and longitude of the city centroid where firms' headquarter is located. Orlando (2004) also assumes company's location to be the city centroid of their headquarters. Geographically near firms are those within 50 miles radius and firms outside this radius are considered geographically distant, although other benchmark distances for proximity will also be considered to capture the effect. Detailed computation of geographical proximity score is given in Methodology section.

2.3   Proximity in Innovativeness, R&D intensity and firm performance

Innovation brings its own risk pertaining to uncertainty it brought but underinvesting in innovation may expose firms to the risk of being knocked out. Required level of innovativeness cannot be

generalized for firms over various industries and so the risk. How a firm is close or distant from its rival firms in its innovation efforts is an important parameter to capture its competitiveness and risk exposure. For one industry certain level of innovation might be an industry norm but for a firm in another industry it may be underinvestment over overinvestment. Eisdorfer and Hsu (2011) argue that firms that fail in technology competition are more likely to go bankrupt and firms in technology driven industries face a real risk of failure if they don't keep innovation pace. We propose innovation competition is more likely to effect a firm survival based on its innovative position within its own product market industry. On the other side there are studies that have linked high R&D intensity with bankruptcy as well (Zhang 2015). Study propose that inability of firms to cope up in innovation race in the industry will expose them to risk of bankruptcy while firms going way far in innovative efforts are also exposed to risk considering the uncertainty and ambiguity that prevails around the nature of R&D investments resulting in higher stock returns.

H3: Proximity in innovation of a firm to rival firms in its industry significantly affect the R&D attributable performance

Impact on R&D attributable performance is captured through the interaction effect of firm's R&D and firm's innovation proximity to its industry counterparts. Firms' R&D intensity is used here as a proxy to measure innovation efforts carried out by a firm. Innovation proximity is calculated as the absolute value of the difference between a firm's R&D intensity and the median ratio in its industry. To make proximity measure comparable across industries, the difference is then scaled by the industry's R&D intensity.

3. Data and Methodology

This section provides details of data, sample and variables used in the study along with their measurement. Empirical analysis used to test hypothesis of the study is also detailed in this section.

3.1 Data and Sample

Sample data for study comprises of stocks listed on NYSE, AMEX and Nasdaq from 1975 till 2016[5]. Annual data of the firms is extracted from CRSP COMPUSTAT merged database (CCM), stock returns data is from Centre for Research in Security Prices (CRSP) while geographical data is extracted from Geographic Names Information System database (GNIS). Sample selection is based primarily on the matching of firm observations in databases and availability of data for measurement of our variables. We have excluded the firm year observations where data for R&D intensity measures, firm performance or stock returns is missing[6.] We have also excluded observations with negative equity (Hirshleifer et al., 2013; Kothari et al., 2002) and sales revenue less than $ 5 million (Ciftci and Cready, 2011; Ali et al., 2012). Merged data from Compustat and CRSP is reduced down to companies located only in US, resulting into 14,795 firm year observations, comprising of 1,683 companies from 654 different geographical locations.   For geographic data it is assumed that companies are located on city centroids following Orlando (2004). Data on headquarters is extracted from Compustat. There are 440 observations of 79 companies in the sample for which data on headquarter was missing in Compustat which is then extracted from Bloomberg and SEC filing. Data for geographic coordinates of location is primarily extracted from Geographic Names Information System database and companies for which geographical information is unmatched in databases or is missing in GNIS, latitude and longitude information is extracted for each location using google maps.

3.2 Variables Measurement

For R&D intensity we have used R&D scaled over total assets of the firm (as adopted by Ebarhart et al, 2004; Lin and Wang, 2016; Anagnostopoulou and Levis, 2008; Li, 2011 and Zhang, 2011). We have

---

[5] Time frame is selected on the basis of standardization of accounting treatment for R&D which was done in October 1974 by SFAS no. 2. Studies including Chan, Lakonishok & Sougiannis, 2001 ; Ciftci & Cready, 2011; Eisdorfer & Hsu, 2011; Li, 2011; Liu & Wong, 2011; Chen, Chen, Liang and Wang, 2013 and others have considered standardization of R&D treatment in their sample selection.

[6] There is a large number of firm-year observations where R&D is not reported. Out of the 254,064 firm-year observations in Compustat for our sample period, there are 141,215 observations where R&D is not reported. Most of the R&D based studies have excluded observations from analysis where R&D is not reported, including Chan et al. (2001), Kothari et al. (2002), Li (2011), Hirshleifer et al. (2013), Cohen et al. (2013) and Zhang (2015).

also carried robustness estimates with alternative measures of R&D intensity including log value of R&D (RD) and R&D expenditures scaled over sales revenue (RDS). Performance measures are based on five years ahead performance and include NPM (net profit margin) which is profit margin measured as net income before extraordinary items adjusted for depreciation, R&D and advertising expenditures and scaled by sales revenue and ROA which is return on assets computed as net income before extraordinary items adjusted for depreciation, R&D and advertising expenditures divided by total assets. Control variables include MV which is market capitalization, BMV which is book to market value, LEV is market leverage, CPM is Capital expenditure measured as capital expenditure scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Proximity measures are detailed in the following sections.

3.2.1   Measuring Geographical Proximity

Each firm is assigned a geographical proximity score based on the distance of the firm from its rival firms. To compute the GP (geographical proximity score), first of all each firm's data on latitude and longitude of the city centroid where firm's headquarter is located is paired up with longitude and latitude data of rival firms. Companies are assumed to be located on city centroids, where data on latitude and longitude of the centroid is extracted from Geographic Names Information System database available on US Geological Survey Website[7]. For each firm i, distance is computed between firm and each of the other firm in the same industry by pairing up data on their location[8], where industries are defined on the basis of Fama and French 49 industries classification.

After measuring the distance of firm i with each of its rival firms distance scores are assigned to each

---

[7] http://geonames.usgs.gov

[8] Study has adopted Vincenty's formula to compute geographical distance which is based on a true ellipsoidal surface distance measurement. World Geodetic System (WGS) which is a standard for use in geodesy and satellite navigation including GPS, use ellipsoidal Earth model. There are some accuracy issues regarding distance measurement of antipodal points using Vincenty's formula but that is not of concern in this study as this study has to measure the surface distance for which Vincenty's formula give error of less than 0.05 mm (Vincenty, 1975a).

of the pair of firm; 1 for a firm which is close to firm i and 0 for the firm which is distant from firm i

and 5O miles radius is used as a Cut-off distance for determining close and distant firms as used by

Orlando (2004). So for those rival firms which are within 50 miles radius, value of 1 is assigned and for

those firms which are located outside the 50 miles radius, value of 0 is assigned. Once each distance

is converted into distance score, average geographical proximity score is then computed for each firm

i which is the sum of distance scores divided by number of firms in industry excluding firm i, given as

follows

$$GP{i,t} = \frac{\sum_{iy,t=1}^{n=k-1} D{iy,t}}{k-1} \qquad (3.1)$$

While,

$$D_{iy,t} = 0 \text{ if } DS_{iy,t} \geq 50 \text{ and } D_{iy,t} = 1 \text{ if } DS_{iy,t} < 50 \qquad (3.2)$$

Where GPi,t is geographical proximity of firm i with its rival firms y in year t. Average proximity of firm

with rival firms is only expected to change if there is change of location of headquarter, exit of a rival

firm from industry or entry of new firm in its industry. $D_{iy,t}$ shows distance score 0 or 1 computed on

the basis of raw distance $DS_{iy,t}$ of firm i from firm y (rival firm) in its respective industry in year t, n

shows the number of distance points in firm i's industry and k represent number of total firms in any

industry. Average score lies between 0 to 1, with firm have 1 score if all competitor firms are located

in close proximity (within 50 miles radius) and firm has 0 score if none of the competitor firm is in

close proximity. More the score is closer to 1 more the firm is in geographical proximity of its

competitor firms and more the score is closer to 0 more the firm is distant from its competitor firms.

3.2.2   Measuring Technological Proximity

Orlando (2004) defined technological proximity on the basis of industrial classes which means that

firms in broadly classified SIC sectors are technologically distant while firms in narrowly defined SIC

sectors are technologically closer to each other. However, this study is focussed on within industry

proximity and distance, so we define technological proximity as whether the firm is at technological

core or fringe of industry. For measurement, study adapts Haushalter, Klasa & Maxwell (2007)

approach to find similarity in firms' operations within industry and the measure is based on MacKay and Phillips's (2005) defined capital to labour ratio to determine whether a firm is at the technological core or fringe of its industry. For each firm i, capital to labour ratio (CL_{it}) is computed each year t, which is calculated by dividing firm's net Property, Plant and Equipment (PPENT from Compustat) by its number of employees (EMP from Compustat). Then average capital to labour ratio for each industry (CL_y) is computed and absolute difference of firm's capital to labour ratio and its respective industry's capital to labour ratio is calculated. Further to make technological proximity measure comparable across industries, the difference is scaled by the industry's average capital to labour ratio. So the technological proximity of any firm with its industry rivals in any year is computed as shown in equation below.

$$TPi,t \; = \; \frac{|CLi,t - \overline{CL}k,t|}{\overline{CL}k,t} \qquad\qquad (3.3)$$

While,

$$\overline{CL}k,t \; = \; \frac{\sum_{k,t=1}^{n=k} CLk,t}{K} \qquad\qquad (3.4)$$

Where TPi,t shows technological proximity of firm i with set of its rival firms y in year t, CLi,t is firm i's capital to labour ratio, $\overline{CL}$k,t is average capital to labour ratio of k firms in the industry which firm i belongs to in year t. Smaller measurement value of TPi,t indicates greater similarity of firm's operations and thus technological proximity with industry rivals and more interdependence of investment opportunities. It can be noted here that study has used absolute difference of firm and industry's capital to labour ratio as the purpose of study is to capture the proximity to industry average irrespective of being positive or negative. However robustness tests will be carried out with positive and negative values of difference of firm's CL and industry's CL. In that case the positive difference indicates firm being more capital intensive than industry in its operations while negative value indicates firm being more labour intensive than industry average.

3.2.3 Measuring Proximity in Innovativeness

This variable measures the relative position in context of firms' innovation efforts in its industry to determine how close or far firm is from industry counterparts in innovation race. This measure is

calculated as the difference between a firm's R&D intensity and the median R&D intensity ratio in its industry. To make proximity measure comparable across industries, the difference is then scaled by the industry's R&D intensity. Negative measurement value indicates firm's innovation efforts are below industry, value closer to zero indicates that firm is investing more or less the same as industry average while company is said to be placing more efforts in innovation as the value becomes more and more positive.

$$IPi,t \ = \ \frac{|RDi,t - \overline{RD}k,t|}{\overline{RD}k,t} \tag{3.5}$$

While,

$$\overline{RD}k,t \ = \ \frac{\sum_{k,t=1}^{n=k} RDMk,t}{K} \tag{3.6}$$

Where $IP_{iy,t}$ shows proximity in innovation of firm i with set of its rival firms y in year t, $RD_{i,t}$ is firm i's R&D intensity measured by R&D to market capitalization of the firm, $RD_{k,t}$ is average R&D intensity of the industry which firm i belongs to and K is the total number of firms in respective industry.

3.3   Methodology

Study proposes that firms having high similarity in operations to industry counterparts share growth opportunities with rivals and thus compete for similar nature of investments. Companies' R&D efforts are more susceptible to be affected by this interdependence due to the nature of R&D investments and presence of time lapse between initiation and completion of R&D initiatives. This may lead companies having similar nature of operations to loose on their R&D efforts or share the benefits, while firms distant in technological proximity enjoys competitive advantage for being distinctive in their operations from industry counterparts. So, study assumes a positive interaction effect of technological proximity and R&D intensity on firm's performance, as higher values of TP score means firm is holding technological distance (as elaborated in section 3.2.1).

For role of geographical proximity of a firm with industry counterparts, study assumes that if firms benefit through the knowledge spillover effect due to being in close proximity to its fellow industry firms (Audretsch and Feldman, 1996; Jaffe, Trajtenberg, and Henderson, 1993; Capello 2009) then

there R&D spending will be more productive and will generate more profits compared to firms which are geographically distant and less able to cultivate industrial spillovers, thus presuming a positive interaction effect of geographical proximity and R&D intensity. While, interaction effect of R&D intensity and innovation proximity is proposed to be negative, pertaining more distant firm is in its innovation efforts from its industry rivals, there is more risk of company being knocked out by competitive forces. Spending lower R&D than average industry R&D spending also indicates underinvestment in growth opportunities and potential of creating predator behaviour on part of competitors. So firms investing relatively low in R&D compared to industry average spending will have higher stock returns. So to test our hypotheses, following regression models have been adopted to carry out analysis for each of proximity measures of firms:

$$P_{i,t+5} = \alpha_i + \beta_1 RDI \times TP_{i,t} + \beta_2 RDI_{i,t} + \beta_3 TP_{i,t} + \beta_K C_{i,t} + \delta_i + \vartheta_t + u_{i,t} \tag{3.7}$$

$$P_{i,t+5} = \alpha_i + \beta_1 RDI \times GP_{i,t} + \beta_2 RDI_{i,t} + \beta_3 GP_{i,t} + \beta_K C_{i,t} + \delta_i + \vartheta_t + u_{i,t} \tag{3.8}$$

$$P_{i,t+5} = \alpha_i + \beta_1 RDI \times IP_{i,t} + \beta_2 RDI_{i,t} + \beta_3 IP_{i,t} + \beta_K C_{i,t} + \delta_i + \vartheta_t + u_{i,t} \tag{3.9}$$

Where,

$P_{i,t+1}$	is average performance over 5 subsequent years from year t+1 to t+5, performance is captured by Earnings (EAR) and return on assets (ROA), where earnings are measured as Net income before depreciation, R&D expenditures and advertising expenditures scaled over sales revenue while ROA is net income before depreciation, R&D expenditures and advertising expenditures scaled over total assets of the firm.
$RDI_{i,t}$	is research and development intensity of firm i over time t, where R&D intensity is captured by R&D intensity scaled over total assets of the firm in year t.
$TP_{i,t}$	denotes technological proximity of the firm i to its industry rivals which is measured by absolute difference of capital to labour ratio of firm i to industry median capital to labour ratio in year t and scaled on industry median capital to labour ratio
$GP_{i,t}$	represents Geographical proximity in terms of geographically distant and close firms based on the presence of rival firms within 50 miles radius of city centroid where firm is located.
$IP_{i,t}$	shows Innovation proximity and is measured by difference of R&D sending of firm and average R&D spending in industry and scaled over industry average
$C_{i,t}$	is the vector for control variables including size of the firm (MV) captured by market

capitalization, book to market value of equity (BMV), leverage (LEV), capital expenditures (CPM) measured as property, plant and equipment add investment and advances scaled over market capitalization and advertising expenditures (ADM) which is advertising expenditures scaled on market capitalization.

δ   denotes set of time dummies

θ   denotes set of industry dummies

We have followed Ciftci and Cready (2011) approach to analyse impact of current R&D on 5 years ahead average profitability[9]. R&D intensity is measured as R&D expenditures (XRD from compustat) scaled over total assets of firm (AT from compustat). Ebarhart et al (2004) Lin and Wang (2016), Anagnostopoulou and Levis (2008), Li (2011) and Zhang (2011) have scaled R&D on total assets to capture R&D intensity. Other widely used measure is R&D scaled over sales revenue as used by Al-Horani (2003), Ebarhart et al (2008), Li (2011), Ehie and Olibe, (2010), Lin and Wang (2016). We have used RDA (R&D over total assets) for our main analysis, however we have carried out robustness checks using other measures of R&D including RDS (R&D scaled over sales revenue) and RD (Log of R&D).

4. Results

Estimates are carried out separately for each measure of proximity. Following sections present results from estimates evaluating role of technological proximity, geographical proximity and innovation proximity.

---

[9] Studies also used 5 year lagged R&D expenditures assuming earnings to be function of 5 years lagged earnings (Lev and Sougiannis, 1996) as follows

$$E_t = d_0 R\&D_t + d_1 R\&D_{t-1} + d_2 R\&D_{t-2} + d_3 R\&D_{t-3} + d_4 R\&D_{t-4} + d_5 R\&D_{t-5}$$

However, Ciftci and Cready argued this approach complicates the analysis while using interaction effects for two reasons; firstly it leads to the estimation of multiple R&D terms as well as multiple R&D interaction terms. All of these terms would have to be estimated and aggregated, and associated standard errors would need to be derived and secondly conventional regression approaches only estimate the marginal impact of variables, after controlling for other variables in the model. Consequently, some form of structured lagged estimation procedure would probably be necessary which are analytically complicated. So following Ciftci and Cready this study is also analysing impact of current R&D on 5 years ahead average profitability.

4.1 Technological proximity, R&D intensity and firm performance

Table 2 shows the impact of technological proximity and R&D intensity, where R&D intensity is measured by R&D to total assets of firm and Technological proximity is measured as the absolute value of the difference between a firm's ratio of net plant and equipment per employee and the mean ratio in its industry which is then scaled on industry average to make measure comparable across industries. Smaller measurement value indicates technological proximity with industry rivals, while larger value indicates firm is at technological fringe. Technological proximity is found to significantly affect the relationship of R&D intensity with all performance measures (Table 2). Consistent with hypothesis 3a the interaction term of technological proximity and R&D intensity is significantly positive for profit margins and return on assets with coefficients of 0.4836 and 0.3054 respectively (from column II of table 2). This positive interaction means that increase in performance with increasing R&D intensity is more in firms with high TP score (technologically distant) than low TP score (technologically near). Quantifying this effect by taking all variables other than R&D intensity and technological proximity constant and rearranging the equation 3.7, it will take the following form:

$$P_{i,t+1} = (\beta_1 TP_{i,t} + \beta_2) RDI_{i,t} + (\alpha_i + \beta_3 TP_{i,t})$$

Where $(\beta_1 TP_{i,t} + \beta_2)$ shows the effect of change in R&D intensity on performance at varying technological proximity scores. This shows that the slope of R&D intensity over performance would increase with increase in technological proximity score. Higher the TP value higher would be the slope that means performance over increasing R&D intensity would increase with firm getting distant in its technology from industry counterparts, so the impact of R&D intensity on performance will vary with varying TP scores. To quantify this effect separately for each performance measure, the slope for RDA and NPM estimates would equate to (0.4836*TP + 0.5021)[10]. TP would be equal to zero if firm lies at the median of the industry in its nature of technology so at TP=0, the value of slope will be 0. 5021 and as the firm becomes distant from its industry counterparts the value of TP increases and so the

---

[10] Considering estimates of net profit margins along with year and industry dummies presented in column II of table 2

value of slope of RDA to profit margins. Now considering the mean value of TP score in my sample of 0.574, the slope will equate to 0.7797 which is higher than the slope at TP=0. This shows that if RDA increases by 1%, increase in profit margins will be more where TP score is higher (0. 74% at mean TP) compared to where TP score is lower (0.48% at TP=0). For the slope for RDA and ROA estimates, the slope would equate to $(0.3054*TP + 0.4373)$[11], which shows sensitivity of return on assets with change in RDA at varying levels of technological proximity. The value of this slope will be 0. 4373 at TP=0 and as the firm becomes distant from its industry counterparts the value of TP increases and so the value of slope of RDA to profit margins. Now again considering the sample's mean TP score of 0.574, the slope will equate to 0.6127 that is higher than the slope at TP=0, which means more positive impact on return on assets due to increase in R&D intensity as technological distance increases. So the positive interaction effect affirms that firms with high R&D intensity and technologically distant from industry perform better than firms with low R&D intensity and technologically close to industry. Also, firms having same level of R&D intensity perform better if they are technologically distant from industry than firms having same level of R&D intensity and are technologically close to industry counterparts.

Furthermore, technological proximity can be seen holding significant positive impact on firm performance which is robust for estimates of profit net margins (coefficient = 0.0171) but is insignificant for returns on assets. While RDA holds significant positive relationship with firm performance including performance including profit margins (coefficient = 0.5021) and return on assets (coefficient = 0. 4373). Control variables including firm size, book to market ratio, leverage and advertising expenditures are found to have significant relationship with firm performance, where firm size and advertising expenditures positively affect the performance while book to market value and leverage negatively affect the firms' profit margins and returns on assets.

[Insert Table 2 here]

---

[11] Considering estimates of return on assets along with year and industry dummies presented in column II of table 2

The contour plot for predicted net profit margins by RDA and technological proximity (figure 1- plot a) also shows that firms similar in terms of R&D intensity have varying profit margins based on their technological proximity. Firms with high TP score (technologically distant) fall in higher profitability zone compared to firms with low TP score (technologically close) at any level of RDA which infers that increase in technological proximity score, means firm getting more distant from industry in technological proximity, leads to increase firm's net profit margins at any level of RDA. Following Aiken & West's (1991) suggestion for plotting interaction effect for continuous variables at their mean value, one standard deviation above mean value and one standard deviation below mean value, predicted net profit margins are plotted using the regression estimates at three levels of technological proximity; at mean referred as TP(M) in graph, at 1 standard deviation above mean referred as TP(H) and at 1 standard deviation below mean referred as TP(L) (Figure 1- plot b). Mean technological proximity for sample data is 0.574 while standard deviation is 0.5966, making TPM 0.574, TPH equivalent to 1.171 and TPL to be 0.0226. Predicted plots are based on estimates from equation 3.7, where R&D intensity is measured by R&D to total assets (RDA) and performance measure is net profit margin (NPM). Slope of the plots is ($\beta1TP + \beta2$) while control variables are taken constant at their mean values, which is worked out by rearranging the equation 3.7 as follows:

$$P_{i,t+1} = (\beta1TP_{i,t} + \beta2) RDI_{i,t} + (\alpha_i + \beta3\ TP_{i,t})$$

So the slopes in figure 3 are ($\beta_1TP_{i,t} + \beta_2$) at three levels of technological proximity; TP_M, TP_H and TP_L. Plot at all levels of technological proximity is positively sloped depicting a positive relationship between RDA and Net profit margins but the slopes and thus predicted NPM differs at varying levels of technological proximity. It can be seen in graph that firms with lower technological proximity to their industry counterparts have higher net profit margins compared to firms closer to industry in their technologically at any level of R&D intensity (measured as R&D total assets). At TP_M, slope equates to 0.7797, at TP_H slope is 1.068 and at TPL slope is equivalent to 0.51312, revealing that increase in net

---

[12] ($\beta TP_{i,t} + \beta_2$) = to (0.4836*TP + 0.5021), which equates to 0.513, 0.7797 and 1.068 f or $TP_L = 0.0226$, $TP_M = 0.574$, and $TP_H = 1.171$ respectively.

profit margins with increase in R&D is higher when firm is technologically distant from industry rivals. So 1% increase in RDA will increase the net profit margins by 0.51% for firms which are technologically closer to industry (TP$_L$), but increase in net profit margins is 1.068% with increase of 1% in RDA if the firm is technologically distant from industry (TP$_H$). It can also be seen from graph that at any particular level of RDM, predicted Net Profit Margins are greater at TP$_M$ than at TP$_H$ and NPM is greater for TP$_L$ than for TP$_M$ or LEV$_H$.

Figure 1 – plot c shows predicted profit margins (NPM) for R&D intensity (RDA) at varying levels of technological proximity with 95% confidence intervals. Technological proximity is taken at varying levels between 0 to 1.4, as 0.03 is the smallest value and 1.4 is the largest value of technological proximity for sample firms. Graph clearly shows how slope of predicted net profit margins change at varying levels of technological proximity, with NPM being highest where firms are technologically distant from industry. Yellow line shows predicted NPM over RDA for firms with score of 1.4 (technologically distant) while blue line shows predicted profit margins for firms with score of 0 (technologically near).

[Insert Figure 1 here]

The positive interaction effect of technological proximity and R&D intensity is in line with the study's hypothesis based on the argument that being technologically distant from industry players give competitive advantage to firms over technologically identical firms in the industry. These results support the argument that there is a higher probability for firms with more technological proximity to invest in similar nature of R&D projects, resulting into more chances for firms to abandon or postpone their R&D initiative if one or the other firm leads in successfully completing the R&D venture. The more similar the firm is to its rival firms in terms of nature of operations more interdependent the firm is in terms of investment opportunities and more vulnerable it is to the risk of losing on R&D investment or share the benefits of similar R&D opportunities compared to firms whose operations are less similar to their industry counterparts.

4.2   Geographical Proximity, R&D intensity and firm performance

Table 3 shows the impact of geographical proximity and R&D intensity, where R&D intensity is measured by R&D expenditures to total assets of firm and geographical proximity is taken as dummy variable of geographically distant and geographically near firms. Firms assigned with 0 value are geographically distant firms which have no other firm from industry within 50 miles radius and geographically near firms are assigned value 1 which are firms which have 1 or more firms from their respected industry located within 50 miles radius. Geographical proximity does not have any significant impact on firm performance, however geographical proximity significantly positively affects firm's net profit margins in interaction with firm's R&D (table 3). Positive interaction effect shows that R&D attributable performance of geographically near firms is better than geographically distant firms. Quantifying this effect by taking all variables other than R&D intensity and technological proximity constant and rearranging the equation 6.8, it will take the following form:

$$P_{i,t+1} = (\beta_1 GP_{i,t} + \beta_2)\, RDI_{i,t} + (\alpha_i + \beta_3\, GP_{i,t})$$

Where $(\beta_1 GP_{i,t} + \beta_2)$ shows the effect of change in R&D intensity on performance at varying geographical proximity. Considering the estimates from table which incorporates both year and industry dummies, the slope would equate to $(0.3854*GP + 0.5523)$[13]. This slope will be then equal to 0.5523 for geographically distant firms (GP=0) and would be equal to 0.9377 for geographically near firms (GP=1), which shows that change in R&D intensity more positively affect the performance of firms located geographically near to their industry counterparts compared to the firms which are geographically distant. Control variables including firm size, book to market ratio, leverage and advertising expenditures are found to have significant relationship with firm performance, where firm size and advertising expenditures positively affect the performance while book to market value and

---

[13] Considering estimates for Net profit margins along with year and industry dummies presented in column II of table 3

leverage negatively affect the firms' profit margins and returns on assets.

[Insert Table 3 here]

Figure 3 shows predicted profit margins (NPM) by R&D intensity (RDA) and geographical proximity with 95% confidence intervals. Net profit margins are predicted against RDA separately for geographically distant and geographically near firms. Blue plot shows predicted values for firms with GP= 0 which are geographically distant firms while red plot shows predicted values for firms geographically near to their industry counterparts. It can be seen in graph that geographically near firms perform better than geographically distant firms as depicted in estimates as well. Predicted plot is based on estimates from equation 3.8, where R&D intensity is measured by R&D to total assets (RDA) and performance measure is net profit margin (NPM). Slope of the plots is $(\beta_1 RP + \beta_2)$ while control variables are taken constant at their mean values, which is worked out by rearranging the equation 6.8 as follows:

$$P_{i,t+1} = (\beta_1 GP_{i,t} + \beta_2) RDI_{i,t} + (\alpha_i + \beta_3 GP_{i,t})$$

So the slopes in figure 3 are $(\beta_1 GP_{i,t} + \beta_2)$ which equates to 0.9377 for geographically near firms having $GP_{i,t}=1$ and it equates to 0.5523 for geographically distant firms having $GP_{i,t}=0$[14]. Plot for both geographically near and distant firms is positively sloped depicting a positive relationship between RDA and Net profit margins but the slopes and thus predicted NPM differs. Slope shows that 1% change in RDA will increase the net profit margins by 0.55% for geographically distant firms but same 1% increase in RDA will lead to increase net profit margins by 0.93% for geographically near firms. Although estimates support this relationship at all levels of R&D intensity, however graph shows that this positive relationship with performance through interaction of geographical proximity and RDA holds true for only those firms investing at least 2% of their assets in R&D expenditures. For firms with lower R&D intensity, performance of firms which are geographically distant is better than firms which

---

[14] Considering estimates for Net profit margins along with year and industry dummies presented in column II of table 3

are geographically near.

[Insert Figure 3 here]

The positive impact of geographical proximity on R&D attributable performance means that firms perform better on their R&D investments if they are geographically near to their industry counterparts. These results support the argument that geographical proximity to industry rivals facilitates voluntary and involuntary knowledge spillover leading to firm's knowledge development and consequently affecting R&D productivity and performance. Study also carried out robust estimates for other measures of R&D intensity including log value of R&D, R&D to sales revenue and (see tables 12, 13 and 14). Results show that log value of R&D highly significantly affects the R&D attributable firm performance where it positively affects net profit margins, returns on assets and returns on equity in interaction with R&D intensity of the firm (table 12). Log value of R&D expenditure may be of more relevance in terms of geographical proximity where the whole argument is based on knowledge spillover, while knowledge spillover is more likely to be dependent on magnitude of innovative activity in geographical proximity rather than its scaled intensity.

4.3   Innovation Proximity, R&D intensity and firm performance

Table 4 shows the impact of geographical proximity and R&D intensity, where R&D intensity is measured by R&D to total assets of firm and R&D proximity is measured as the absolute value of the difference between a firm's R&D intensity and the average ratio in its industry which is then scaled by the industry's average R&D intensity. Smaller measurement value indicates closeness of firm to competitors in innovation efforts while larger value depicts firm is distant from industry counterparts. R&D proximity of firm to industry is found to significantly affect the net profit margins of the firm. Furthermore interaction effect of R&D proximity and R&D intensity is significantly negatively affect the net profit margins and return on assets in interaction with firm's R&D intensity. It reveals that firms having same R&D intensity across industries tend to differ in R&D performance based on their

relative position in R&D intensity in their own industry. Firms closer to industry in R&D intensity have higher performance (profit margins and return on assets) compared to those which are R&D distant. Quantifying this effect by taking all variables other than R&D intensity and technological proximity constant and rearranging the equation 6.9, it will take the following form:

$$P_{i,t+1} = (-\beta_1 IP_{i,t} + \beta_2) RDI_{i,t} + (\alpha_i + \beta_3 IP_{i,t})$$

Where $(-\beta_1 IP_{i,t} + \beta_2)$ shows the effect of change in R&D intensity on performance at varying innovation proximity scores. The negative interaction effect shows that the slope of R&D intensity over performance would decrease with increase in innovation proximity score. Higher the IP value lower would be the slope that means performance over increasing R&D intensity would increase at decreasing rate for firms which are distant from industry. To quantify this effect separately for each performance measure, the slope for RDA and NPM estimates would equate to $(-0.3685*TP + 1.1166)$[15]. IP would be equal to zero if firm lies at the mean of the industry in its innovation efforts, so at IP=0 the value of slope will be 1.1166 and as the firm becomes distant from its industry counterparts the value of IP will increase and the value of slope of RDA to profit margins will decline. Now considering the mean value of IP score in my sample of 0.71, the slope will equate to 0.855 which is lower than slope at IP=0. This shows that innovation proximity has a conditional impact on performance related to R&D intensity, where positive impact R&D intensity over return on assets declines as innovation distance of firm from industry counterparts increases. For the slope for RDA and ROA estimates, the slope would equate to $(-0.2975*TP + 0.892)$[16], which shows sensitivity of return on assets with change in RDA at varying levels of innovation proximity. The value of this slope will be 0. 892 at IP=0 and as the firm becomes distant from its industry counterparts the value of IP increases and the value of slope of RDA to profit margins declines. Now again considering the sample's mean IP score of 0.71, the slope will equate to 0.681 that is lower than the slope at TP=0, which means more positive impact

---

[15] Considering estimates for net profit margins along with year and industry dummies presented in column II of table 4

[16] Considering estimates for returns on assets along with year and industry dummies presented in column II of table 4

on return on assets due to increase in R&D intensity declines as innovation distance increases.

[Insert Table 4 here]

The contour plot for predicted net profit margins by RDA and R&D proximity (figure 2- plot a) shows net profit margins by R&D intensity (RDA) and innovation proximity. The plot is based on estimates from column II table 4 for net profit margins. IP score (innovation proximity) as indicated on left side of the plot indicates firm being distant or close to counterpart firms in the industry. Higher IP score means firm is distant from industry counterparts and lower score means firms is closer to industry in its R&D efforts. Plot shows that firms similar in terms of R&D intensity have varying profit margins based on their R&D proximity to rival firms. Dark blue zone in the contour plot reveals that change in net profit margins due to change in innovation proximity is indifferent of innovation proximity of firms. However as R&D intensity increases, the innovation proximity plays its role and it can be seen in contour plot that R&D proximity positively affects net profit margins. At higher RDA levels firms can lie in lower or higher NPM zones based on their R&D proximity. Curvature of NPM zones show that firms tend to earn higher margins if their IP score is lower means they are closer to industry in their R&D efforts compared to firms which are distant.

Again, predicted net profit margins are plotted using the regression estimates at three levels of R&D proximity; at mean referred as IP(M) in graph, at 1 standard deviation below mean referred as IP(L) and at 1 standard deviation above mean referred as IP(H) (Figure 2- plot b). Mean innovation proximity for sample data is 0.6145 while standard deviation is 0.4323, making RP_M 0.6145, RP_H equivalent to 0.1822 and RP_L to be 1.0468. Predicted plots are based on estimates from equation 3.9, where R&D intensity is measured by R&D to total assets (RDA) and performance measure is net profit margin (NPM). Slope of the plots is $(\beta_1 RP + \beta_2)$ while control variables are taken constant at their mean values, which is worked out by rearranging the equation 3.9 as follows:

$$P_{i,t+1} = (\beta_1 RP_{i,t} + \beta_2) RDI_{i,t} + (\alpha_i + \beta_3 RP_{i,t})$$

So the slopes in figure 2 plot b are ($\beta_1 RP_{i,t} + \beta_2$) at three levels of R&D proximity; RP_M, RP_H and RP_L. Plot at all levels of technological proximity is positively sloped depicting a positive relationship between RDA and Net profit margins but the slopes and thus predicted NPM differs at varying levels of R&D proximity. Figure 3 plot c shows predicted net profit margins plotted against RDA at varying levels of innovation proximity with 95% confidence intervals. Innovation proximity is taken at varying levels between 0 to 1.7, as 0.04 is the smallest value and 1.7 is the largest value of innovation proximity score for sample firms. It can be seen that unlike higher R&D intensity firms, firms with low RDA show increase in net profit margins when they are distant from industry in their R&D efforts.

[Insert Figure 2 here]

4.4   Robustness tests

We carried out various robustness checks to validate findings of the study. We use log value of R&D expenditures instead of scaled R&D to capture R&D intensity and results remain unchanged. Results are much more robust in case of geographical proximity where R&D intensity is measured by log level of R&D where interaction effect of geographical proximity and R&D intensity is highly significant for all measures of performance. Log value of R&D expenditure may be of more relevance in terms of geographical proximity where the whole argument is based on knowledge spillover, while knowledge spillover is more likely to be dependent on magnitude of innovative activity in geographical proximity rather than its scaled intensity. Furthermore, I also carried out robust estimates measuring technological proximity using mean of industry's capital to labour ratio instead of median and found results to remain significant. For performance we took into account net profitability of firm reported in the main analysis, however studies have worked with operating performance as well including Eberhart, Maxwell and Siddique (2004), Ciftci and Cready, (2011), Chen, Chen, Liang and Wang (2013) and Hirshliefer, Hsu and Li (2013). I carried out estimates based on operating profitability and found all results remain similar and significant. Ciftci and Cready (2011) also used 1 year ahead firm performance in addition to five year performance, so we carried out an additional analysis for 3 year

ahead and 1 year ahead firm performance and our conclusions remain intact. Further analysis has been carried out for high R&D firms following Lev & Sougiannis (1996), Chan et al (2001), Eberhart et al.(2008), Shi (2008) and Lin and Wang (2016). Based on Fama and French 49 industries classification, we identified six industries including include Pharmaceutical (Industry 13), Automobile and Trucks (Industry 23), Defence (26), Communication (Industry 32), Computer Hardware (Industry 35), Computer Software (Industry 36), Electronic Equipment (Industry 37) and Measuring & Control Equipment (Industry 38) as high R&D industries which are identical to industries that have been identified by existing studies (Lev and Sougiannis, 1996; Chan et al, 2001; Eberhart et al., 2008; Lin and Wang, 2016) and we found that conclusion remain unchanged for all proximity measure.

5. Conclusion

Technological proximity positively moderates the relationship of R&D intensity and firm performance. These findings support the argument that there is a higher probability for firms with more technological proximity to invest in similar nature of R&D projects, resulting into more chances for firms to abandon or postpone their R&D initiative if one or the other firm leads in successfully completing the R&D venture. The more similar the firm is to its rival firms in terms of nature of operations more interdependent the firm is in terms of investment opportunities and more vulnerable it is to the risk of losing on R&D investment or share the benefits of similar R&D opportunities compared to firms whose operations are less similar to their industry counterparts. This results into competitive advantage for technologically distant firms. In line with study's hypothesis, the positive impact of geographical proximity on R&D attributable performance means that firms perform better on their R&D investments if they are geographically near to their industry counterparts. These results support the argument that geographical proximity to industry rivals facilitates voluntary and involuntary knowledge spillover leading to firm's knowledge development and consequently affecting R&D productivity and performance. Innovation proximity is also found to be significant and negative inferring firms closer to industry in their innovation efforts tend to perform better with increase in

R&D than firms distant in their innovation efforts.

References

Albino, Vito, Garavelli A. C., Schiuma G. 1998. Knowledge transfer and inter-firm relationships in industrial districts: the role of the leader firm. Technovation. 19(1), 53-63.

Aw B. Yan, Mark J. Roberts, and Daniel Yi Xu (2011). R&D Investment, Exporting, and Productivity Dynamics. American Economic Review 101 (June): 1312–1344

Boari, C., Lipparini, A. 1999. Networks within Industrial Districts: Organising Knowledge Creation and Transfer by Means of Moderate Hierarchies. Journal of Management & Governance 3, 339–360

Capello R., 2007. Regional economics. Routledge.

Chan L. K. C., Josef Lakonishok and Theodore Sougiannis, 2001. The Stock Market Valuation of Research and Development Expenditures. The Journal of Finance, Vol. 56, No. 6, pp. 2431-2456

Chen, Sheng-Syan, Yan-Shing Chen, Woan-lih Liang and Yanzhi Wang 2013. R&D Spillover Effects and Firm Performance Following R&D Increases. Journal of Financial and Quantitative Analysis Vol. 48, No. 5, Oct. 2013, pp. 1607–1634

Chung KH, Wright P, Kedia B., 2003. Corporate governance and market valuation of capital and R&D investments. Review of Financial Economics. 31;12(2):161-72.

Ciftci, Mustafa and William M.Cready (2011), Scale effects of R&D as reflected in earnings and returns. Journal of Accounting and Economics 52 (2011) 62–80

Czarnitzki, Dirk and Kraft, Kornelius 2012. Spillovers of innovation activities and their profitability. Oxford Economic Papers 64(2), 302-322

Eberhart Allan, Willaim Maxwell, and Akhtar Sidique (2008). A Reexamination of the Tradeoff between the Future Benefit and Riskiness of R&D Increases. Journal of Accounting Research. Volume 46, Issue 1(March), Pages 27–52

Eberhart, A.C., Maxwell, W.F., Siddique, A.R., 2004. An examination of long-term excess stock returns and operating performance following R&D increases. Journal of Finance 59, 623–651.

Ellison, Glenn, and Edward L. Glaeser. 1999 "The Geographic Concentration of Industry: Does Natural Advantage Explain Agglomeration?" The American Economic Review, vol. 89, no. 2, 1999, pp. 311–316. JSTOR, www.jstor.org/stable/117127.

Franzen, L., K. Rodgers, and T. Simin, 2007, "Measuring distress risk: The effect of R&D intensity. Journal of Finance 62, 2931-2967.

Freeedman, M. L. 2008. Job Hopping, Earnings Dynamics, and Industrial Agglomeration in the Software Publishing Industry. Journal of Urban Economics, vol. 64, pp. 590600.

Froot, K.A., Scharfstein, D.S., Stein, J.C., 1993. Risk management: coordinating corporate investment and financing policies. Journal of Finance 48, 1629–1658.

Gu, Lifeng, 2016. Product Market Competition, R&D Investment and Stock Returns. Journal of Financial Economics, 119, 441–455

Haushalter, David, Sandy Klasa, and William F. Maxwell, 2007. The influence of product market dynamics on the firm's cash holdings and hedging behavior, Journal of Financial Economics 84, 797–825.

Hirschey, M., Skiba H. and Wintoki M. B. 2012. The size, concentration and evolution of corporate R&D spending in U.S. firms from 1976 to 2010: Evidence and implications. Journal of Corporate Finance 18(3), 496-

518.

Hirshleifer, D., Po-Hsuan Hsu and Dongmei Li (2013). Innovative efficiency and stock returns. Journal of Financial Economics, 107 (2013) 632–654

Hsu P-H (2009) Technological innovations and aggregate risk premiums. Journal of Financial Economics. 94(2):264–279

Jaffe, A.B and Henderson, R. 1993. Geographic Localization of Knowledge Spillovers as Evidenced by Patent tions. Quarterly Journal of Economics, 108, 577-598

Jaffe, A.B and Trajtenberg, M. 1999. International Knowledge Flows: Evidence from Patent Citations." Economics Innovation and New Technology, 8, 105-136

Lev, B., Sougiannis, T., 1996. The capitalization, amortization and value-relevance of R&D. Journal of Accounting & Economics 21, 107–138. Lev, B., Zarowin, P., 1999. The boundaries of financial reporting and how to extend them. Journal of Accounting Research 37, 353–385.

Li, Dongmei. 2011. Financial Constraints, R&D Investment, and Stock Returns. Review of Financial Studies, 24 (9): 2974-3007

Liu, Qiao, Kit Pong Wong, (2011) Intellectual Capital and Financing Decisions: Evidence from the U.S. Patent Data. Management Science 57(10):1861-1878

Maskell, Peter 2001. Towards a Knowledge-based Theory of the Geographical Cluster. Industrial and Corporate Change, Volume 10(4), 921–943. https://doi.org/10.1093/icc/10.4.921

Orlando, Michael J. 2004. Measuring Spillovers from Industrial R&D: On the Importance of Geographic and Technological Proximity. The RAND Journal of Economics 35(4), 777-786.

Silvaa, Dakshina G. D. and McComb, Robert P. 2012. Geographic concentration and high tech firm survival. Regional Science and Urban Economics, 42(4), 691-701.

Vincenty, T. 1975a. Direct and inverse solutions of geodesics on the ellipsoid with application of nested equations, Survey Review 22(176), 88-93

Zhang, Wei (2015). R&D Investment and Distress Risk. Journal of Empirical Finance. Volume 32, June 2015, 94-11

Table 1: Descriptive Statistics

Variables	Mean	Median	Standard Deviation	Minimum	Maximum
NPM	0.209238	0.15563	0.176522	0.010352	0.690961
ROA	0.224734	0.183174	0.164624	0.014758	0.655254
RDA	0.051132	0.027528	0.058254	0	0.203166
RD	2.3521	1.9609	2.0568	0	6.6794
CPL	61545	24643	191181	0	7438667
TP	0.573994	0.405204	0.596597	0	1.4091
DIST	1048	984	455	0	4894
GP	0.0741	0.0400	0.1212	0	1
IP	0.6145	0.5547	0.4323	0.0410	1.7251
MV	5.6362	5.4933	2.4253	1.9134	10.3327
BMV	0.6722	0.5259	0.5029	0.1045	1.9622
LEV	0.2105	0.1569	0.1994	0	0.6645
CP	0.4784	*0.4993*	0.2194	0.0841	0.8208
ADV	0.0368	0.0208	0.0262	0	0.0953

This table shows descriptive statistics for data sample used for third empirical chapter which comprises of firms located in US. Performance measures include ROA which is return on assets computed as net income before extraordinary items divided by total assets, and NPM (net profit margin) is profit margin measured as net income before extraordinary items divided by sales revenue. In R&D intensity measures, RDA is R&D expenditures scaled on total assets and RD is log value of R&D expenditures. In technological proximity, CPL shows the capital to labour ratio of firms in million dollars per employee, computed as Property Plant and Equipment to Employees of the firm, TP is technological proximity computed on base of distance from industry median while. GP is geographical proximity score ranges which between 0 to 1, where 1 shows all firms of industry within cut-off distance point of 50 miles radius and 0 shows none of the companies from same industry lie within 50 miles radius. R&D proximity shows how close firm is from its rival firms in R&D intensity, where RDAMP shows distance of firm from firms in industry based on R&D to market capitalization, RDAP is based on R&D to book value of assets and RDSP is based on R&D to sales revenue of the firm.

Table 2: Interaction effect of firms' Technological Proximity to industry counterparts and R&D Intensity on Firm performance

	NPM		ROA	
	I	II	I	II
RDAxTP	0.4046***	0.4836***	0.2947**	0.3054**
	(2.66)	(3.64)	(2.06)	(2.27)
RDA	0.9494***	0.5021***	0.6529***	0.4373***
	(6.54)	(3.07)	(4.60)	(2.80)
TP	0.0237***	0.0171**	(0.01)	(0.01)
	(2.89)	(2.46)	(-1.49)	(-1.34)
MV	0.0072***	0.0098***	(0.00)*	0.00
	(3.71)	(4.65)	(-1.75)	(0.31)
BMV	-0.0531***	-0.0655***	-0.1014***	-0.1103***
	(-4.61)	(-5.83)	(-8.61)	(-10.25)
LEV	-0.1027***	-0.1213***	-0.2496***	-0.2340***
	(-2.91)	(-3.83)	(-7.46)	(-7.60)
CPM	(0.01)	(0.00)	0.0283***	0.02
	(-1.25)	(-0.45)	(2.95)	(1.77)
ADM	0.4191***	0.5223***	0.9169***	0.9026***
	(3.43)	(4.85)	(7.82)	(8.19)
Year Dummy	No	Yes	No	Yes
Industry Dummy	No	Yes	No	Yes
N	6903	6903.00	6903.00	6903.00
R squared	0.30	0.36	0.27	0.33
F	54.14	13.93	57.11	15.25

***significant at 1%, **significant at 5%, *significant at 10%

This table shows interaction effect of firms' technological proximity to industry counterparts and R&D intensity on firm performance using OLS estimates with coefficients and t-statistics in parenthesis (based on heteroscedasticity robust standard errors). Column I shows estimates without year and industry dummies while column II shows estimates with year and industry dummies for each performance estimates. Performance measures are based on five years ahead performance and include NPM (net profit margin) which is profit margin measured as net income before extraordinary items adjusted for depreciation, R&D and advertising expenditures and scaled by sales revenue and ROA which is return on assets computed as net income before extraordinary items divided by total assets. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). TP is technological proximity measured as the absolute distance of firm's capital to labour from industry's median capital to labour ratio and scales in median capital to labour ratio. TP*RDA is interaction of technological proximity (TP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value, LEV is market leverage, CPM is Capital expenditure measured as capital expenditure scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization.

Table 3: Interaction effect of firms' Geographical Proximity to industry counterparts and R&D intensity on Firm performance (5 years ahead)

	NPM		ROA	
	I	II	I	II
RDAxGP	0.4563**	0.3854**	0.19	0.20
	(2.29)	(2.02)	(0.95)	(1.07)
RDA	0.9034***	0.5523***	0.6943***	0.5017***
	(5.56)	(3.11)	(4.28)	(2.89)
GP	(0.01)	(0.01)	(0.00)	(0.01)
	(-0.66)	(-1.29)	(-0.26)	(-1.52)
MV	0.0082***	0.0110***	(0.00)	0.00
	(4.24)	(5.16)	(-1.70)	(0.45)
BMV	-0.0561***	-0.0679***	-0.1001***	-0.1086***
	(-4.74)	(-5.90)	(-8.48)	(-10.08)
LEV	-0.0968***	-0.1170***	-0.2487***	-0.2314***
	(-2.75)	(-3.65)	(-7.51)	(-7.60)
CPM	(0.01)	(0.00)	0.0271***	0.01
	(-1.05)	(-0.19)	(2.82)	(1.55)
ADM	0.3612***	0.4724***	0.9083***	0.8941***
	(2.95)	(4.28)	(7.78)	(8.21)
Year Dummy	No	Yes	No	Yes
Industry Dummy	No	Yes	No	Yes
N	6963.00	6963.00	6963.00	6963.00
R squared	0.28	0.34	0.31	0.32
F	47.76	12.64	14.93	15.07

***significant at 1%, **significant at 5%, *significant at 10%

This table shows interaction effect of firms' technological proximity to industry counterparts and R&D intensity on firm performance using OLS estimates with coefficients and t-statistics in parenthesis (based on heteroscedasticity robust standard errors). Column I shows estimates without year and industry dummies while column II shows estimates with year and industry dummies. Performance measures are based on five years ahead performance and include NPM (net profit margin) which is profit margin measured as net income before extraordinary items adjusted for depreciation, R&D and advertising expenditures and scaled by sales revenue and ROA which is return on assets computed as net income before extraordinary items divided by total assets. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). GP is geographical proximity measured as a dummy variable carrying value of 1 if the average distance of firm from its rival firms is below the cut-off point of 50 miles radius and it carries value of 0 if the average distance of firm from rival firms is more than the 50 miles radius. GP*RDA is interaction of geographical proximity (GP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value, LEV is market leverage, CPM is Capital expenditure measured as capital expenditure scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization.

Table 4: Interaction effect of firms' Innovation Proximity to industry counterparts and R&D Intensity on Firm performance

	NPM		ROA	
	I	II	I	II
IPxRDA	-0.5063***	-0.3685**	(0.31)*	-0.2975*
	(-2.83)	(-2.02)	(-1.66)	(-1.70)
RDA	1.5853***	1.1166***	1.1029***	0.8920***
	(8.41)	-5.24	(6.09)	-4.41
IP	0.02	0.0317*	0.01	0.0257*
	(1.39)	-2.25	(0.73)	-2.1
MV	0.0088***	0.0119***	(0.00)	0.001
	(4.36)	-5.29	(-1.34)	-0.51
BMV	-0.0616***	-0.0682***	-0.1041***	-0.1096***
	(-5.04)	(-5.67)	(-8.62)	(-9.78)
LEV	-0.1155**	-0.1188***	-0.2451***	-0.2156***
	(-3.10)	(-3.44)	(-7.54)	(-7.09)
CPM	(0.01)	-0.0026	0.0301**	0.0127
	(-0.63)	(-0.26)	(3.29)	-1.43
ADM	0.4243**	0.4492***	0.9895***	0.9187***
	(2.92)	-3.51	(7.52)	-7.45
Year Dummy	No	Yes	No	Yes
Industry Dummy	No	Yes	No	Yes
N	6513.00	6513	6513.00	6513
R squared	0.28	0.3322	0.27	0.3267
F	48.82	12.4857	55.66	14.8967

***significant at 1%, **significant at 5%, *significant at 10%

This table shows interaction effect of firms' technological proximity to industry counterparts and R&D intensity on firm performance using OLS estimates with coefficients and t-statistics in parenthesis (based on heteroscedasticity robust standard errors). Column I shows estimates without year and industry dummies while column II shows estimates with year and industry dummies for each performance estimates. Performance measures are based on five years ahead performance and include NPM (net profit margin) which is profit margin measured as net income before extraordinary items adjusted for depreciation, R&D and advertising expenditures and scaled by sales revenue and ROA which is return on assets computed as net income before extraordinary items divided by total assets. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Innovation proximity is the measured by absolute difference of firms' R&D intensity form industry's mean R&D intensity and then scaled on median R&D intensity of industry. IP*RDA is interaction of innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value, LEV is market leverage, CPM is Capital expenditure measured as capital expenditure scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization.
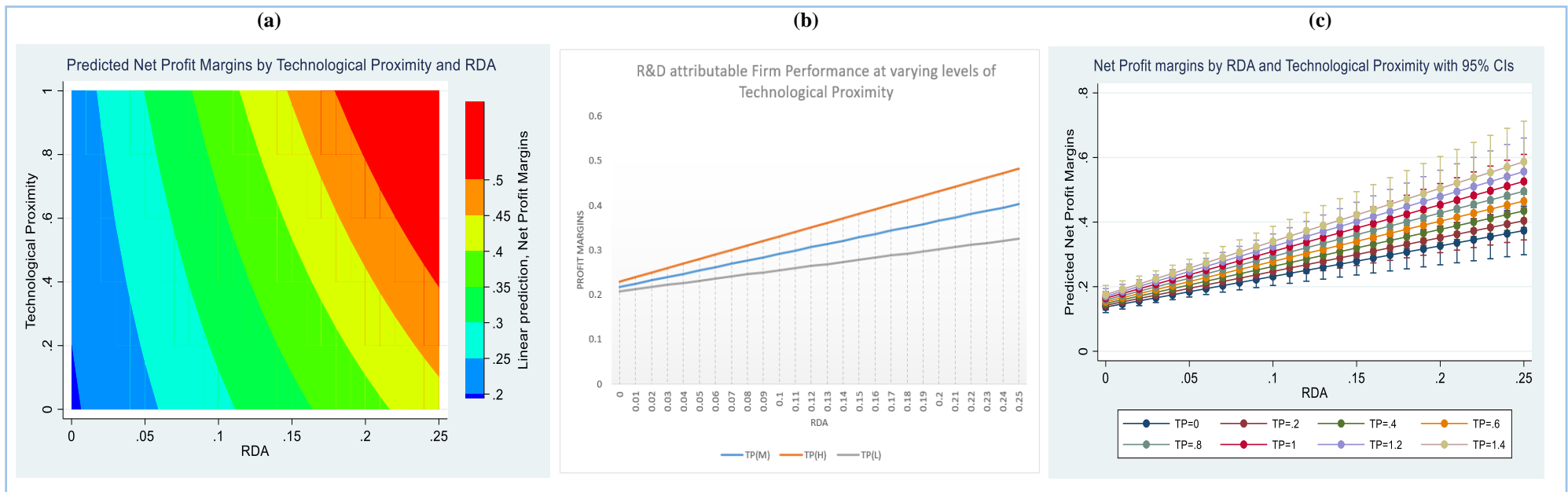
Figure 1: Net profit margins by Technological Proximity and RDA

Figures show predicted net profit margins by RDA and technological proximity based on estimates from table 6 panel A and column I. RDA is R&D intensity measured as R&D to total assets of firm, while technological proximity shows whether the firm is at technological core or technological fringe of industry based on capital to labour ratio of firm. Lower values of TP score shows firm being technologically near to and higher values on the other side shows firm being technologically distant. Figure (a) shows the contour plot for predicted net profit margins by RDA and technological proximity. Figure (b) shows predicted net profit margins by RDA at three levels of technological proximity; at mean referred as TP(M), at 1 standard deviation below mean referred as TP(L) and at 1 standard deviation above mean referred as TP(H), following Aiken & West's (1991) suggestion for plotting interaction effect for continuous variables. Mean technological proximity for sample data is 0.4955 while standard deviation is 0.3578, making TP_M 0.4955, TP_H equivalent to 0.1377 and TP_L to be 0.8534. Predicted plots are based on estimates from equation 3.7, where R&D intensity is measured by R&D to total assets (RDA) and performance measure is net profit margin (NPM). Slope of the plots is ($\beta_1 TP + \beta_2$) while control variables are taken constant at their mean values, which is worked out by rearranging the equation 3.7. Figure (c) shows the predicted net profit margins by RDA at varying levels of technological proximity with 95% confidence intervals. Technological proximity is taken at varying levels from 0 to 1.4, as 0.03 is the smallest value and 1.4 is the largest value of technological proximity for sample firms.

Figure 2: Net profit margins by Innovation Proximity and RDA – Contour plot
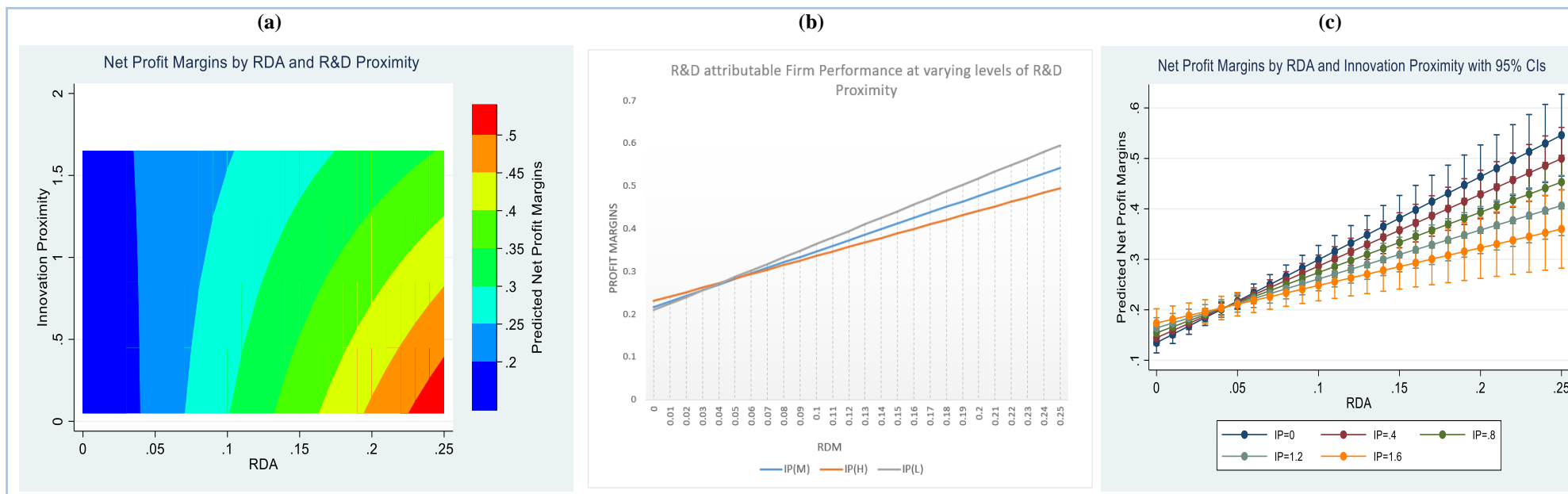
Figure shows the plots for predicted net profit margins by RDA and R&D proximity based on estimates from column I of panel C of table 6. RDA is R&D intensity measured as R&D to total assets of firm, while Innovation proximity shows whether the firm is investing in R&D similar to industry counterparts or is it distant in R&D efforts. Higher R&D proximity score means firm is distant from industry rivals and lower score means firms is closer to industry in its R&D efforts. Figure (a) shows the contour plot for predicted net profit margins by RDA and technological proximity. Figure (b) shows predicted net profit margins by RDA at three levels of technological proximity; at mean referred as TP(M), at 1 standard deviation above mean referred as TP(L) and at 1 standard deviation below mean referred as TP(H), following Aiken & West's (1991) suggestion for plotting interaction effect for continuous variables. Mean technological proximity for sample data is 0.4955 while standard deviation is 0.3578, making TP_M 0.4955, TP_H equivalent to 0.1377 and TP_L to be 0.8534. Predicted plots are based on estimates from equation 3.7, where R&D intensity is measured by R&D to total assets (RDA) and performance measure is net profit margin (NPM). Slope of the plots is ($\beta_1 TP + \beta_2$) while control variables are taken constant at their mean values. Figure (c) shows the predicted net profit margins by RDA at varying levels of R&D proximity with 95% confidence intervals. RDA is R&D intensity measured as R&D to total assets of firm, while R&D proximity shows whether the firm is investing in R&D similar to industry counterparts. R&D proximity is taken at varying levels from 0 to 1.7, as 0.04 is the smallest value and 1.7 is the largest value of R&D proximity score for sample firms.

Figure 3: Net profit margins by Geographical Proximity and RDA

Net Profit Margins by RDA and Geographical Proximity with 95% CIs
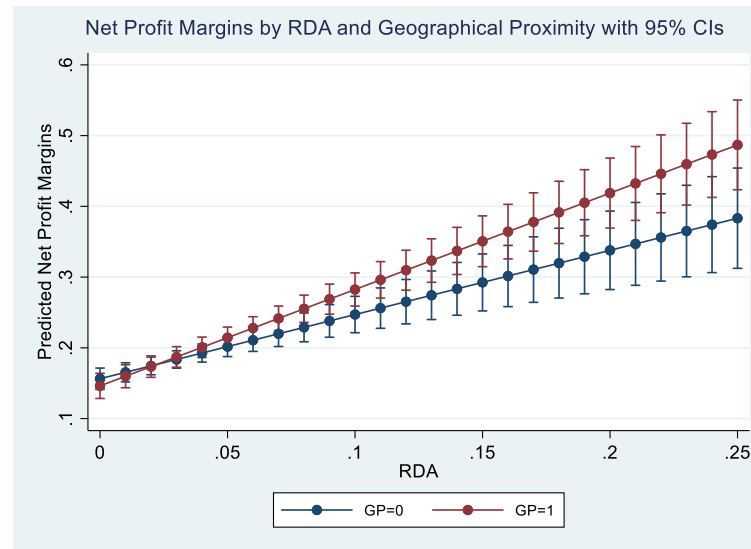
Figures show the predicted net profit margins by RDA and geographical proximity based on estimates from table 6 for measure of net profit margins as presented in column I of panel B. Figure (a) shows net profit margins by for geographically near and distant firms with 95% confidence intervals. Blue plot shows predicted values for firms with GP= 0 which are the firms having none of the firm from their industry within cut-off distance of 50 miles so are categorized as geographically distant firms while red plot shows predicted values for firms which have at least one firm from industry within 50 miles radius and are categorized as geographically near firms. The plot is based on estimates from table 6 for performance measure of net profit margins as presented in column I of the table.

Appendices

A-I: Firms' Technological Proximity to Industry Counterparts and R&D attributable performance using alternate measurement of R&D intensity

	Technological Proximity	
	NPM	**ROA**
RDxTP	0.0087**	0.00
	(3.23)	(1.54)
RD	0.01	0.0106*
	(1.13)	(2.35)
TP	0.01	(0.00)
	(1.50)	(-0.51)
MV	0.00	-0.0092*
	(0.27)	(-2.46)
BMV	-0.0726***	-0.1180***
	(-6.22)	(-10.52)
LEV	-0.1726***	-0.2755***
	(-5.16)	(-8.93)
CPM	(0.00)	0.02
	(-0.49)	(1.68)
ADM	0.5155***	0.8910***
	(4.84)	(8.37)
Year dummy	Yes	Yes
Industry dummy	Yes	Yes
Adj R	0.33	0.31
F	11.83	14.12

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. R&D intensity is measured by log value of R&D expenditures (RD). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RD is interaction of technological proximity (TP) and R&D intensity (RD. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-II: Firms' Geographical Proximity to Industry Counterparts and R&D attributable performance using alternate measurement of R&D intensity

	B-Geographical Proximity	
	NPM	ROA
RDxGP	0.0109**	0.0112***
	(2.94)	(3.48)
RD	0.01	0.01
	(1.26)	(1.67)
GP	(0.01)	-0.0258*
	(-1.14)	(-2.25)
MV	0.00	-0.0089*
	(0.58)	(-2.44)
BMV	-0.0758***	-0.1166***
	(-6.35)	(-10.43)
LEV	-0.1560***	-0.2642***
	(-4.69)	(-8.74)
CPM	(0.00)	0.01
	(-0.25)	(1.48)
ADM	0.4521***	0.8709***
	(4.15)	(8.41)
Year dummy	Yes	Yes
Industry dummy	Yes	Yes
Adj R squared	0.32	0.31
F	11.93	14.93

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by log value of R&D expenditures (RD). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RD is interaction of technological proximity (TP) and R&D intensity (RD), GP*RD is interaction of geographical proximity (GP) and R&D intensity and IP*RD is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-III: **Firms' Innovation Proximity to Industry Counterparts and R&D attributable performance using alternate measurement of R&D intensity**

	C-Innovation Proximity	
	NPM	ROA
RDxIP	-0.0007	-0.0027
	(-0.21)	(-1.00)
RD	0.0152*	0.0194***
	-2.47	-3.97
IP	0.0187	0.0234*
	-1.68	-2.34
MV	0.0002	-0.0130**
	-0.04	(-3.12)
BMV	-0.0813***	-0.1241***
	(-6.45)	(-10.51)
LEV	-0.1689***	-0.2617***
	(-4.65)	(-8.53)
CPM	-0.0034	0.0129
	(-0.32)	-1.41
ADM	0.4215***	0.8879***
	-3.31	-7.33
Year dummy	Yes	Yes
Industry dummy	Yes	Yes
Adj R squared	0.3034	0.3105
F	11.1851	14.0497

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by log value of R&D expenditures (RD). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RD is interaction of technological proximity (TP) and R&D intensity (RD), GP*RD is interaction of geographical proximity (GP) and R&D intensity and IP*RD is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-IV: **Firms' Technological Proximity to Industry Counterparts and R&D attributable performance using alternate measurement of R&D intensity (RDS)**

	Technological Proximity	
	NPM	ROA
RDxTP	0.15	0.13
	(1.36)	(1.39)
RD	0.5654***	(0.01)
	(4.12)	(-0.07)
TP	0.0219**	(0.00)
	(3.06)	(-0.55)
MV	0.0088***	0.00
	(4.28)	(0.07)
BMV	-0.0722***	-0.1127***
	(-6.44)	(-10.32)
LEV	-0.1274***	-0.2562***
	(-4.11)	(-8.44)
CPM	(0.00)	0.01
	(-0.13)	(1.57)
ADM	0.5734***	0.9038***
	(5.35)	(8.60)
Year dummy	Yes	Yes
Industry dummy	Yes	Yes
Adj R	0.37	0.30
F	14.26	13.95

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. R&D intensity is measured by R&D expenditures scaled over sales revenue (RDS). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RD is interaction of technological proximity (TP) and R&D intensity (RD. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-V: Firms' Geographical Proximity to Industry Counterparts and R&D attributable performance using alternate measurement of R&D intensity

	B-Geographical Proximity	
	NPM	**ROA**
RDxGP	0.25	0.22
	(1.51)	(1.53)
RD	0.5402***	(0.05)
	(3.44)	(-0.40)
GP	(0.01)	(0.01)
	(-1.12)	(-1.27)
MV	0.0098***	0.00
	(4.80)	(0.11)
BMV	-0.0740***	-0.1112***
	(-6.47)	(-10.17)
LEV	-0.1202***	-0.2518***
	(-3.87)	(-8.36)
CPM	0.00	0.01
	(0.08)	(1.38)
ADM	0.5370***	0.8961***
	(4.97)	(8.62)
Year dummy	Yes	Yes
Industry dummy	Yes	Yes
Adj R squared	0.36	0.30
F	13.54	14.12

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by R&D expenditures scaled over sales revenue (RDS). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RD is interaction of technological proximity (TP) and R&D intensity (RD), GP*RD is interaction of geographical proximity (GP) and R&D intensity and IP*RD is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-VI: **Firms' Innovation Proximity to Industry Counterparts and R&D attributable performance using alternate measurement of R&D intensity**

	C-Innovation Proximity	
	NPM	ROA
RDxIP	-0.0007	-0.0027
	(-0.21)	(-1.00)
RD	0.0152*	0.0194***
	-2.47	-3.97
IP	0.0187	0.0234*
	-1.68	-2.34
MV	0.0002	-0.0130**
	-0.04	(-3.12)
BMV	-0.0813***	-0.1241***
	(-6.45)	(-10.51)
LEV	-0.1689***	-0.2617***
	(-4.65)	(-8.53)
CPM	-0.0034	0.0129
	(-0.32)	-1.41
ADM	0.4215***	0.8879***
	-3.31	-7.33
Year dummy	Yes	Yes
Industry dummy	Yes	Yes
Adj R squared	0.3034	0.3105
F	11.1851	14.0497

***significant at 1%, **significant at 5%, *significant at 10%
This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by R&D expenditures scaled over sales revenue (RDS). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RD is interaction of technological proximity (TP) and R&D intensity (RD), GP*RD is interaction of geographical proximity (GP) and R&D intensity and IP*RD is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-VII: Firms' Technological Proximity to Industry Counterparts and R&D attributable performance with alternate measurement of technological proximity

A-Technological Proximity		
	NPM	ROA
RDxTP	0.0130**	0.0023
	(2.05)	(0.5)
RD	0.0268***	0.0209***
	-5.26	-4.65
TP	0.0112	-0.0016
	-0.61	(-0.11)
MV	-0.0180***	-0.0185***
	(-5.21)	(-5.75)
BMV	-0.0762***	-0.1176***
	(-6.08)	(-10.37)
LEV	-0.1843***	-0.2896***
	(-4.57)	(-8.90)
CPM	-0.0277**	0.0032
	(-2.36)	-0.35
ADM	0.3745***	0.8844***
	-3.09	-8.48
Year dummy	6903	6903
Adj R	0.248	0.2817
F	9.5919	15.081

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on five years ahead performance and include PM which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-VIII: **Firms' Technological Proximity to Industry Counterparts and R&D attributable performance with alternate performance measurement**

A-Technological Proximity		
	PM	**ROA**
RDAxTP	0.5906*	0.6849**
	-1.8	-2.38
RDA	0.9523***	0.3708*
	-4.61	-1.86
TP	0.0299*	-0.0306**
	-1.69	(-2.38)
MV	0.0131***	-0.0006
	-5.19	(-0.27)
BMV	-0.0708***	-0.1372***
	(-4.92)	(-10.08)
LEV	-0.0349	-0.2236***
	(-0.81)	(-5.91)
CPM	-0.0377**	0.0015
	(-2.85)	-0.14
ADM	0.3402**	0.9379***
	-2.42	-7.61
Year dummy	Yes	Yes
Adj R	0.2792	0.2814
F	12.5723	15.4225

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on five years ahead performance and include PM which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-IX: Firms' Geographical Proximity to Industry Counterparts and R&D attributable performance with alternate performance measurement

	B-Geographical Proximity	
	OPM	OROA
RDAxGP	0.5635**	0.1929
	-2.39	-0.83
RDA	0.8971***	0.5933***
	-4.75	-3.14
GP	-0.0173	-0.0102
	(-1.39)	(-0.89)
MV	0.0121***	-0.0008
	-5.02	(-0.37)
BMV	-0.0748***	-0.1368***
	(-5.18)	(-9.93)
LEV	-0.0337	-0.2241***
	(-0.79)	(-5.96)
CPM	-0.0362**	-0.0001
	(-2.75)	(-0.00)
ADM	0.2942**	0.9408***
	-2.12	-7.73
Year dummy	Yes	Yes
Adj R squared	0.2729	0.2776
F	12.0475	15.8016

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-X: Firms' Innovation Proximity to Industry Counterparts and R&D attributable performance with alternate performance measurement

	C-Innovation Proximity	
	OPM	OROA
RDAxIP	-0.5370**	-0.3621*
	(-2.51)	(-1.66)
RDA	1.6644***	1.0744***
	-7.26	-4.82
IP	0.0212	0.0181
	-1.34	-1.24
MV	0.0123***	-0.0004
	-4.82	(-0.19)
BMV	-0.0815***	-0.1374***
	(-5.47)	(-9.80)
LEV	-0.0457	-0.1982***
	(-0.99)	(-5.21)
CPM	-0.0332**	-0.0021
	(-2.45)	(-0.19)
ADM	0.3413**	0.9626***
	-2.06	-6.87
Year dummy	Yes	Yes
Adj R squared	0.2693	0.2823
F	12.001	15.5745

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on five years ahead performance and include EAR which is firm's earnings from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on sales revenue, while ROA is return on assets of the firm from t+1 to t+5 and is measured as operating income before depreciation, advertising and R&D expenditures and scaled on total assets. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XI: **Firms' Technological Proximity to Industry Counterparts and R&D attributable performance over 3 years**

	Technological Proximity	
	NPM	ROA
RDAxTP	0.2711	0.2458
	-1.39	-1.56
RDA	0.8131***	0.4706***
	-7.07	-4.52
TP	0.0284**	-0.0102
	-2.67	(-1.50)
MV	0.0125***	0.0031*
	-7.78	-2.48
BMV	-0.0384***	-0.0791***
	(-4.40)	(-10.63)
LEV	-0.0737**	-0.1925***
	(-2.88)	(-8.91)
CPM	-0.0221**	0.0046
	(-2.73)	-0.71
ADM	0.3571***	0.8003***
	-3.91	-10.36
Year dummy	Yes	Yes
Adj R squared	0.3064	0.3065
F	16.0361	20.8234

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XII: Firms' Innovation Proximity to Industry Counterparts and R&D attributable performance over 3 years

	Geographical Proximity	
	NPM	ROA
RDAxGP	0.2684**	0.0523
	-1.99	-0.39
RDA	0.7727***	0.5661***
	-7.13	-5.2
GP	-0.0061	-0.0068
	(-0.82)	(-1.09)
MV	0.0118***	0.0030*
	-7.43	-2.42
BMV	-0.0415***	-0.0792***
	(-4.66)	(-10.68)
LEV	-0.0721**	-0.1908***
	(-2.82)	(-8.89)
CPM	-0.0204*	0.004
	(-2.49)	(-0.62)
ADM	0.3250***	0.8010***
	-3.56	-10.49
Year dummy	Yes	Yes
Adj R squared	0.2969	0.3035
F	14.9958	20.7687

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XIV: Firms' Innovation Proximity to Industry Counterparts and R&D attributable performance over 3 years

	Innovation Proximity	
	NPM	**ROA**
RDAxIP	-0.4607***	-0.2453**
	(-3.98)	(-2.14)
RDA	1.3155***	0.8262***
	-10	-7.21
IP	0.0211*	0.0109
	-2.29	-1.35
MV	0.0121***	0.0033*
	-7.39	-2.55
BMV	-0.0452***	-0.0789***
	(-5.13)	(-10.35)
LEV	-0.0847**	-0.1810***
	(-3.15)	(-8.53)
CPM	-0.0176*	0.0037
	(-2.17)	-0.59
ADM	0.3510**	0.8035***
	-3.28	-9.12
Year dummy	Yes	Yes
Adj R squared	0.2989	0.306
F	15.1623	20.1069

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XV: Firms' Technological Proximity to Industry Counterparts and R&D attributable performance over 1 years

	NPM	ROA
RDAxTP	0.0264	0.0266
	-0.18	-0.24
RDA	0.6451***	0.3477***
	-7.66	-4.72
TP	0.0310***	-0.0052
	-3.39	(-0.95)
MV	0.0153***	0.0065***
	-11.44	-6.61
BMV	-0.0254***	-0.0589***
	(-3.90)	(-10.92)
LEV	-0.0851***	-0.1774***
	(-4.49)	(-11.37)
CPM	-0.0183**	0.0017
	(-3.09)	-0.38
ADM	0.3633***	0.7502***
	-5.23	-13.6
Year dummy	Yes	Yes
Adj R squared	0.2638	0.2752
F	17.8703	26.7306

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings in year t+1 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XII: **Firms' Geographical Proximity to Industry Counterparts and R&D attributable performance over 1 years**

	Geographical Proximity	
	NPM	ROA
RDAxGP	0.0343	0.0103
	-0.36	-0.14
RDA	0.4283***	-0.0111
	-5.06	(-0.17)
GP	0.0006	-0.0007
	-0.12	(-0.16)
MV	0.0137***	0.0051***
	-10.73	-4.76
BMV	-0.0297***	-0.0599***
	(-4.59)	(-11.17)
LEV	-0.0926***	-0.1975***
	(-4.93)	(-12.25)
CPM	-0.0174**	-0.0035
	(-2.95)	(-0.74)
ADM	0.3620***	0.7157***
	-5.26	-13.1
Year dummy	Yes	Yes
Adj R squared	0.2559	0.252
F	16.0217	25.7944

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings in year t+1 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XIII: Firms' Innovation Proximity to Industry Counterparts and R&D attributable performance over 1 years

	Innovation Proximity	
	NPM	**ROA**
RDAxIP	-0.3442***	-0.1683*
	(-4.23)	(-2.19)
RDA	0.9313***	0.5224***
	-10.2	-6.63
IP	0.0151*	0.0073
	-2.13	-1.23
MV	0.0150***	0.0068***
	-11.14	-6.72
BMV	-0.0305***	-0.0585***
	(-4.84)	(-10.65)
LEV	-0.0965***	-0.1727***
	(-4.87)	(-11.14)
CPM	-0.0145*	0.0019
	(-2.47)	-0.43
ADM	0.3680***	0.7540***
	-4.65	-12.12
Year dummy	Yes	Yes
Adj R squared	0.2608	0.2741
F	17.39	25.9951

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings in year t+1 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XIX: **Firms' Technological Proximity to Industry Counterparts and R&D attributable performance for high R&D industries**

	Technological Proximity	
	NPM	**ROA**
RDAxTP	0.3706	0.6199**
	-1.1	-1.96
RDA	0.5153**	0.2377
	-2.09	-1.07
TP	0.0583*	-0.0145
	-1.79	(-0.50)
MV	0.0211***	0.0090***
	-5.18	-2.74
BMV	-0.0744***	-0.1267***
	(-2.99)	(-5.92)
LEV	-0.1693**	-0.2649***
	(-2.00)	(-4.44)
CPM	-0.0247	0.013
	(-0.89)	-0.66
ADM	0.6192*	1.2349***
	-1.71	-4.59
Year dummy	Yes	Yes
Adj R squared	0.2732	0.2791
F	8.482	8.8989

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings in year t+1 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XX: **Firms' Geographical Proximity to Industry Counterparts and R&D attributable performance for high R&D industries**

	Geographical Proximity	
	NPM	ROA
RDAxGP	0.4569*	0.1084
	-1.64	-0.38
RDA	0.3894	0.4852**
	-1.57	-2.2
GP	-0.018	-0.0035
	(-0.66)	(-0.15)
MV	0.0195***	0.0083**
	-4.81	-2.53
BMV	-0.0845***	-0.1295***
	(-3.39)	(-6.06)
LEV	-0.1837**	-0.2615***
	(-2.15)	(-4.38)
CPM	-0.0156	0.0134
	(-0.56)	-0.68
ADM	0.5546	1.2158***
	-1.56	-4.54
Year dummy	Yes	Yes
Adj R squared	0.2556	0.2697
F	7.3661	8.1946

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings in year t+1 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.

A-XXI: Firms' Innovation Proximity to Industry Counterparts and R&D attributable performance for high R&D industries

	Innovation Proximity	
	NPM	**ROA**
RDAxIP	-0.6389**	-0.6185**
	(-2.06)	(-2.11)
RDA	1.2533***	1.1026***
	-4.32	-4.03
IP	0.0446	0.0439
	-1.04	-1.24
MV	0.0194***	0.0076**
	-4.81	-2.38
BMV	-0.0907***	-0.1367***
	(-3.69)	(-6.64)
LEV	-0.1827*	-0.2596***
	(-2.16)	(-4.36)
CPM	-0.0107	0.0186
	(-0.39)	-0.97
ADM	0.5531	1.1943***
	-1.48	-4.29
Year dummy	Yes	Yes
Adj R squared	0.2586	0.2781
F	7.5073	8.8406

***significant at 1%, **significant at 5%, *significant at 10%

This table shows regression estimates for interaction effect of firms' proximity to industry counterparts and R&D intensity on firm performance, with coefficients and t-statistics in parenthesis based on heteroscedasticity robust standard errors. Table comprises of three panels, where panel-A shows results for technological proximity, panel-B for geographical proximity and panel-C shows estimates for Innovation proximity. R&D intensity is measured by scaling R&D expenditures on firm's total assets (RDA). Performance measures are based on three years ahead performance and include EAR which is firm's earnings in year t+1 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on sales revenue in year t, while ROA is return on assets of the firm from t+1 to t+3 and is measured as net income before depreciation, advertising and R&D expenditures and scaled on total assets in year t. TP*RDA is interaction of technological proximity (TP) and R&D intensity (RDA), GP*RDA is interaction of geographical proximity (GP) and R&D intensity and IP*RDA is interaction of Innovation proximity (IP) and R&D intensity. Control variables include MV which is market capitalization, BMV which is book to market value of equity, LEV is market leverage, CPM is Capital expenditure measured as capital expenditures scaled on market capitalization and ADM is advertising expenditures scaled on market capitalization. Year dummies are included in the analysis.