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Innovation, Corporate Governance and Market Structure: An Analysis of Indian Manufacturing Firms

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Abstract:

The paper attempts to observe the relationship between the concentration of corporate governance/family-ownership and innovation activities in the Indian manufacturing sector. The results from Tobit estimation corroborate the earlier findings that family-owned firms put in greater efforts in innovation activities and therefore seem to carry a stewardship attitude towards the long-run growth of the firm. As an important addition to the literature, the moderating role of the product market competition in determining the relationship between corporate governance and innovation has been explored extensively in the paper. We find that family firms may adopt a different attitude towards

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R&D investments when they are exposed to different levels of competition. However, results are contingent upon the measure of product market competition in our model. Additionally, a desegregate analysis using samples of group-affiliated and standalone firms suggests that the findings cannot be generalized to the entire manufacturing sector.

1. Introduction

Innovation is crucial for industrial growth (Mansfield 1962; Scherer, 1965; Mowery 1983; Colombelli et al. 2013), but what factors determine a firm's ability to innovate? To answer this question, a large body of research emerged. Some of this research attributed to the market structure as the primary motivation for innovation (see Arrow 1962; Schumpeter 1943; Aghion et al. 2005). Another strand of research highlighted the role of corporate governance (Kim, Kim, and Lee 2008; Ortega-Argilés, Moreno, and Caralt 2005; Okamuro and Zhang 2006. Chen 2009; Kellerman et. al. 2012; Lodh et. al. 2014, Ashwin et. al. 2015; Patel and Chrisman 2014). Nonetheless, there exist very few studies addressing the moderating effect of market concentration/competition on corporate governance while analysing the latter's effect on innovation (Aghion et. al. 1999; Aghion et. al. 2002; Ugur and Hashem 2012; Buchwald and Thorwarth 2015). In this paper, we address this issue in the context of an emerging economy, India. Following are the three main questions we are dealing with in this study: (1) How does corporate governance influence the innovative activities of Indian manufacturing firms? (2) What is the moderating role of product market competition on corporate governance in influencing innovation? (3) Does the influence of market competition on the relationship between corporate governance and innovation differ between business group firms and standalone firms?

The stream of literature investigating how corporate governance influences the innovation of firms focuses on several dimensions of corporate governance, such as corporate ownership, management, finance and labour (Lacetera 2001; Casper and Matraves 2003; Michie and Sheehan 2003; Shipton et al. 2005; Lerner 2010; Sapra, Subramanian, and Subramanian 2014; Ughetto 2010; Aghion, Reenen, and Zingales 2013). These studies highlighted that the innovation performance of individual firms depends not only on market characteristics but also on corporate governance structure. This line of research follows from the work of Coase (1937) which states that the firm is not a black box, rather an organization in which the contribution of several stakeholders plays important role in productive activities. Following this view, corporate governance plays a leading role in an analysis of innovation, because not only the physical resources but also the integration of human resources with it, plays a crucial role to determine R&D investments in a firm.

On the other hand, researchers focussed on the relationship between innovation and market competition motivated by the works of Schumpeter (1934, 1942). Schumpeter (1934) argues that individual entrepreneurs are the key actors for innovative activities in firms', leading to the process of 'creative destruction'. Small, new firms, according to this view, are more flexible to overcome organizational inertia and are more prone to innovative activities (Belloc 2012). Later on, Schumpeter (1942) reviewed this hypothesis and proposed a new perspective characterized by a 'creative accumulation' pattern. According to this view, large, older firms with monopolistic power are the driving forces of innovative activities because they have a higher capability to exploit resource-intensive R&D activities which, in turn, leads to higher returns for firms. These two opposing views lead to opposing hypotheses on the relationship between market competition and innovation. Following these two studies, there emerged several studies to investigate the relationship between market structure and innovation (Belloc 2012; Kamien and Schwartz 1975; Cohen and Levin 1989; Van Cayseele 1998 among others).

The market structure seems to affect the managerial agency problem. It has been observed that innovation is slow under monopoly, as the managers enjoy a "quiet life" (Hicks 1935). The risk-averse manager may be reluctant to spend on R&D investments under a monopoly. To motivate the "lazy" managers to work hard, product market competition plays an important role (Hart 1983; Schmidt 1997; Raith 2003; Karuna 2007; Bertrand and Mullainathan 2003). Hence, the moderating role of competition in influencing innovation may be different under different corporate governance structures. There exist very few studies that have investigated the combined effect of market competition and corporate governance on innovation (Aghion, Carlin, and Schaffer 2002; Ugur and Hashem 2012). To fill this gap, we address this issue in this paper in the context of manufacturing firms in India.

Agency problem between managers and shareholders takes a different form in family firms in emerging economies like India. In India, the ownership structure is highly concentrated in the hands of family members. More than 75% of firms are family-owned in India (Pant and Pattanayak 2007). In these family firms, agency problem arises between controlling shareholders and minority shareholders, which is known as the principal-principal agency perspective (Dharwadkar, George, and Brandes 2000; Young et al. 2008). Based on this perspective, it can be argued that in the case of a family-owned firm, the ultimate decisions are more likely to be influenced by the interest of the family rather than management or minority shareholders. Young et al. (2008) argue that family members having the majority shares in the firm can be more concerned with the family's interest rather than the overall welfare maximization of the firm. This behaviour of controlling family members may lead to expropriation of firm resources, risk aversion, and nepotism, further resulting in under-investment in R&D activities along with other crucial activities related to the firm's growth. Contrary to the principal-principal agency perspective, stewardship theory (Davis, Schoorman, and Donaldson 1997) suggests that controlling family members in a firm focus on the continuity of the business; hence they are encouraged to invest more in R&D.

Additionally, other characteristics such as group affiliation may also play an important role in determining the firms' decision to put in more efforts in R&D (see Hsieh, Yeh, and Chen 2010). Chang, Chung, and Mahmood (2006) argue that a group's abilities to share technical knowledge and financial resources among affiliated firms may assist them in promoting innovation in emerging economies. At the same time, the group's diversification strategies may constrain individual affiliated firms' innovativeness. Similarly, the independence of the managing board can also be an important determinant of R&D investments. A more independent board may also serve as an effective guardian and resource provider to encourage R&D investments of the firms (Chen and Hsu 2009).

In this study, corporate governance has been represented by aspects such as family ownership and control, family CEO, family CEO-chairperson duality and board independence. We also investigate the moderating role of market competition on the relationship between corporate governance and innovation of business group affiliation and stand-alone firms, separately. The random effect panel Tobit model has been applied on the panel of 777 companies in the manufacturing industries to test our hypotheses.

This study has several major contributions to the literature. First, most of the earlier studies are concerned with the developed economies, whereas we focus on an emerging economy like India. Second, earlier studies on India have considered one particular industry like Pharmaceuticals (Ashwin, Krishnan, and George 2015) or publicly listed firms (Lodh, Nandy, and Chen 2014). We have considered the entire manufacturing industry in India, which may have important policy implications. Third, earlier studies on India considered only agency, stewardship and institutional perspectives (Ashwin, Krishnan, and George 2015; Lodh, Nandy, and Chen 2014). We have extended our theoretical discussion and its empirical applications beyond these perspectives which may be considered as an important contribution to the literature. Fourth, our study highlights how family involvement affects the strategic behaviour of firms under competition. Thus, we investigate whether product market competition and corporate governances are substitutes or complements, by interacting each indicator of corporate governance with market competition. This is an addition to the existing studies on India (Ashwin, Krishnan, and George 2015). Fifth, this study compares the behaviour of business groups vis-à-vis stand-alone firms which has significance in the context of the recent debate in India which challenges the role of business groups in improving firm performance (Richter and Chakraborty 2015) and hence their contribution to innovation. Earlier arguments of "institutional voids" (Khanna and Palepu 1997) are no longer valid in the Indian context, following the liberalization of capital markets since July 1991. Thus, this study is an important addition to this ongoing debate in the context of India.

The findings reveal that corporate governance indicators of our interest and product market competition are significant factors affecting innovations of the firms positively. More specifically, concentrated family ownership, management control and more independent board result in greater investments in R&D. As a new contribution to the literature, we find that, as a determinant of innovative activities of the firms, there is complementarity between corporate governance and the level of market competition. Additionally, the family's stewardship attitude and the moderating role of competition is found to be more prominent among standalone firms than group affiliates.

The next section will discuss the relevant theoretical arguments in detail and provide us with hypotheses for subsequent analysis.

The third section provides methodological details along with information related to data and variable construction; preliminary observations have been given in the fourth section; the fifth section elaborates on the empirical results and finally, the sixth section concludes the study.

2. Review of Literature and Hypothesis Development

This section explores the relevant literature and constructs arguments for the hypotheses' development. We will first discuss the theoretical literature analysing the relationship between corporate governance and innovation. Then we will focus on the literature on the role of market competition in influencing the corporate governance-innovation relationship. Finally, we will focus on the literature investigating the role of market competition in the corporate governance-innovation relationship, in the context of business group affiliation vis-à-vis stand-alone firms.

2.1 Corporate Governance and Innovation

Several studies started to investigate the relationship between corporate governance and innovation only in recent years (Bushee 1998; Coriat and Weinstein 2002; Lazonick and O'Sullivan 2000; Tylecote and Ramirez 2006; Munari, Oriani, and Sobrero 2010; Choi, Park, and Hong 2012). One important theoretical perspective to explain such a relationship is derived from agency theory with the focus on managerial decisions to innovate. Several arguments support the prediction that there is a positive relationship between family ownership and innovation. First, as the family members have a long-term perspective about their business, they will emphasize on generational succession (Munari, Oriani, and Sobrero 2010). This will motivate them to invest in R&D activities which will increase their competitive advantages and ensure the long-term survival of firms. Second, managers of a family firm generally belong to the family which would help to reduce the agency costs due to information asymmetry and moral hazard and would support the beneficial innovation activities (Perri and Peruffo 2017).

However, family ownership could also have a negative influence on innovation if family ownership becomes risk-averse due to principal-principal conflicts (Fama 1980; Fama and Jensen 1983). Moreover, family firms try to avoid external equity, in order to keep control over their firms, which may result in capital constraints to undertake R&D activities (Thomsen and Pedersen 2000). This principal-principal conflict of interest is more prominent in the case of decisions pertaining to R&D investments, because of the high risk and uncertainty involved (Aghion and Tirole 1994; Buchwald and Thorwarth 2015). Risk-averse managers may spend less on R&D activities to avoid the risk of failure (Buchwald and Thorwarth 2015). There exists extensive empirical literature which supports the argument that R&D investment is lower in family firms compared to non-family firms (Chen and Hsu 2009; Patel and Chrisman 2014; Chrisman and Patel 2012; R. C. Anderson, Duru, and Reeb 2012; Nieto, Santamaria, and Fernandez 2015; Classen et al. 2014; Duran et al. 2016; Perri and Peruffo 2017).

There are other well discussed theoretical perspectives such as the behavioural agency model (BAM), the family's socio-emotional wealth (SEW) and the stewardship theory. The behavioural agency model (BAM) argues that agents decisions are not rigid rather it depends on different variables having diverse impacts (Wiseman and Gomez-Mejia 1998). Following this perspective, the only thing that concerns decision-makers is to preserve the firm's accumulated endowments (Wiseman and Gomez-Mejia 1998). Thus, the different short-term vs. long-term goals of family firms influences their decision to innovate (Chrisman and Patel 2012).

Socio-Emotional wealth (SEW) of family firms plays an important role in the decision to innovate (Filser et al. 2016; Berrone, Cruz, and Gomez-Mejia 2012; Cennamo et al. 2012; Kotlar et al.

2018 among others). SEW is defined as “the ability to exercise authority, the enjoyment of personal control, “clan membership”, a sense of belonging, affection, intimacy as well as an active role in the family dynasty” (Gomez-Mejia, Makri, and Kintana 2010). SEW involves the non-economic goals of family firms. In well-functioning families, family members support, share responsibilities, and trust each other (Filser et al. 2016). As the family members hold key governance positions in family firms, they have a commitment to the firm which motivates the decision making with a long-time horizon, like innovation. SEW in family firms has some indirect role to play in taking such decisions regarding innovation, a strategy which will help the firm to sustain in the long-term and remain competitive (Levenburg, Schwarz, and Almallah 2002; Classen et al. 2014). On the other hand, due to the long-term nature of innovation, a family firm may lack incentives to innovate since innovative activity involves risks and may engender the survival of the firm and harmful for their SEW (Massis, Minin, and Frattini 2015; Deephouse and Jaskiewicz 2013; Craig et al. 2014). Thus, in the latter case, a family firm’s innovativeness may hurt not only financial wealth but also its reputation (Gast et al. 2018).

Another perspective related to the relationship between family ownership and innovation is drawn from the stewardship theory (Davis, Schoorman, and Donaldson 1997; Ashwin, Krishnan, and George 2015; Le Breton-Miller and Miller 2009). According to this view, the wealth, career opportunities, and reputation of family members are connected to the company’s performance, which in turn will have favourable effects on innovative activities. Some studies focus on family management and governance along with family ownership (Matzler et al. 2015). According to these studies, family management and governance adversely affect R&D activities. Because, the family manager’s objective is to keep control of the firm at the hands of the family, even if such a decision is irrational (Perri and Peruffo 2017). Again, if the board of directors is dominated by family members, the firm may reduce spending on R&D investment to protect the interest of the family. The reverse will be true if there is the presence of independent non-executive directors on board. Finally, it has been observed that duality between the family CEO and chairperson has a positive influence on innovation, due to the effectiveness of decision making by this duality (Ashwin, Krishnan, and George 2015). From the above discussion, we observe that there is a divergent attitude of the family towards innovation. Therefore, the above arguments lead to conflicting hypotheses as follows:

H1: The concentration of family ownership is positively associated with investments in innovation

H2: The concentration of family ownership is negatively associated with investments in innovation

H3: Family management is positively related to investments in innovation

H4: Family management is negatively related to investments in innovation

H5: Family CEO-chairperson duality is positively related to investments in innovation

H6: Family CEO-chairperson duality is negatively related to investments in innovation

2.2 Moderating Effects of Market Competition on the Corporate Governance-Innovation Relationship

There are very few studies that have investigated the joint effect of corporate governance and market competition on innovation (Aghion, Dewatripont, and Rey 1999; Aghion, Carlin, and Schaffer 2002; Ugur and Hashem 2012; Allen and Gale 2000). Aghion et. al. (1999 and 2002) argue that corporate governance may be a substitute or a complement to competition, based on the disciplining role of the two, on the behaviour of managers. If the managers are profit-maximizers these are substitutes whereas if they are non-profit maximizers, i.e., with satisficing managers, these are complements. On the one hand, managers may be reluctant to adopt the strategy of innovation to reduce costs. On the other hand, they may be willing to spend on innovation to avoid the risk of bankruptcy and job loss. Product market competition reduces managerial slack by disciplining managers and hence, induces innovation. Product market competition helps to survive the efficient management team which helps to control a large market share by the company and for the survival of the company they will take up the strategy of innovation (Allen and Gale 2000). If the managers are not working hard, the company will lose market share and the managers will face the threat of job loss and bankruptcy. Hence, product market competition becomes a substitute for corporate governance. However, if a firm follows strict corporate governance rules so that managerial slack is limited and managers follow innovative activities, then product market competition becomes complements to corporate governance.

Leibenstein (1966) has shown that the role of the decision-maker, i.e. manager, is critical for the firm's financial situation. When the managers have certain preferences due to which they may be maximising their private benefits at the cost of firms' profits, so-called X-inefficiencies may arise. When there is a rise in competition, the financial situation of the firm deteriorates as there is downward pressure on the overall profits. This may force the managers to cut down their slack by reducing individual monetary and non-monetary benefits to ensure the firm's survival. Chen and Steinwender (2020) argue that family managers show distinctive preferences that include more than maximising private monetary benefits. For instance, family managers have a strong desire to sustain and build a legacy for their descendants. Family members also enjoy taking pride in the firm as it enables them to use resources for personal purposes and also to provide jobs to their relatives. These monetary/non-monetary benefits will be lost if the firm ceases to exist due to rising competition. This may encourage the family owner/managers to deal with the competition with vigour to ensure survival. Chen and Steinwender (2020) find that a rise in competition resulted in greater productivity in family-managed firms than non-family firms in Spain. The findings suggest that firms with concentrated family ownership/control may invest more in R&D under a high competition situation.

Additionally, it can be argued that product market competition may have an impact on the agency costs of the firms. Theoretical analysis and empirical research in economics have observed that product market competition reduces agency costs (Leventis, Weetman, and Caramanis, 2011). Griffith (2001) argues that competition reduces the profits (hence reduces the incentive to put efforts) whereas, at the same time, it reduces the agency costs (hence increases the incentive to put efforts). The findings suggest that a rise in competition level leads to an increase in efficiency level and firm growth rates. Furthermore, a rise in efficiency is observed in firms with the principal-agent type of set up whereas not in the case of the firms where the principal (owner) and agent (manager) are closely related. It implies that product market competition may be responsible for the increase in productivity through a reduction in agency costs. Baggs and Bettignies (2007) argue that product market competition may have a separate ‘direct pressure effect' as well as 'agency effect' on managerial efficiency. Direct pressure may force the firms to improve quality or decrease costs. Similarly, competition may also reduce agency costs for the principal (owner). Reduction in agency costs makes it cheaper for the principal to elicit greater efforts from the agent. The empirical findings show that both effects are significant. The competition affects the firms differentially, depending on whether they are subject to agency costs or not. The agency effect is noticed in firms that are plagued by the agency (where the agent has superior information than the principal), whereas the direct pressure effect is observed in all the firms.

Now, if the competition is associated with a reduction of agency cost in the case of firms with a principal-agent type of set-up (as shown in the aforementioned studies), it can be argued that the extent of reduction in agency cost due to increasing competition in case of family and non-family firms may be different. Chrisman, Chua, and Litz (2004) argue that family firms generally do not suffer from the kind of agency costs that non-family firms suffer. Based on this, it can be further argued that increased competition may reduce the agency costs of non-family firms and help to improve their performance. However, family firms may get affected by only the direct influence of competition rather than the agency effect. Considering that lower agency costs may be associated with greater R&D investments (Francis and Smith 1995), it can also be argued that under high competition, R&D investments of firms with diluted family ownership/control should increase. In other words, the relationship between family ownership/control and innovation should be negative.

Based on the previous discussion we develop the following two hypotheses:

H7: The higher is the market competition, the stronger is the relationship between corporate governance and innovation. Thus, corporate governance and market competition are complements.

H8: The higher is the market competition, the weaker is the relationship between corporate governance and innovations. Thus, corporate governance and market competition are substitutes.

2.3 Business Groups, Corporate Governance, Market Competition and Innovation

The business groups can be defined as the 'collection of publicly traded firms in a wide variety of industries, with a significant amount of common ownership and control, usually by a family' (Khanna and Palepu 2000) or as the 'corporate organisations wherein several firms are linked through stock-pyramiding and cross-holding structures' (see Almeida and Wolfenzon 2005; Claessens et al. 2002).

Pyramiding and cross-holding structures may intensify principal-principal agency problems among family business groups (Morck and Yeung 2003). Employing of pyramiding structure involves controlling a firm with the help of a chain of other intermediate firms wherein the owner has majority shares but not complete ownership. The family owners may use such structures to enable tunnelling of resources from firms in which they enjoy less cash flow rights to the firms wherein cash flow rights are higher (Johnson et al. 2000). This makes it easy for the family owners to appropriate financial resources for their personal benefits, hence leaving behind a lesser amount for R&D investments. The principal-principal agency problem in family firms may also be exaggerated because of the tendency to engage in activities leading creative to creative self-destruction (Morck and Yeung 2003). Innovations in one of the group-affiliated firms may restrict innovations in other affiliated firms to avoid the potential risk of obsoletion of existing products. The tendency to engage in creative self-destruction makes the business groups maintain the status quo (Ashwin, Krishnan, and George 2015) by limiting the R&D investments of affiliated firms.

The aforesaid features (such as pyramiding, cross-holding and creative destruction) of family firms can be observable largely in the family business groups[1]. The standalone firms, even if owned and controlled by a family, practically can not engage in such activities due to structural and organisational limitations. This suggests that group affiliation may result in a weaker corporate governance-R&D relationship than in standalone firms.

Affiliation to business groups, however, may also encourage

1. Business groups in India are usually dominated by families (Chakraborty 2013)

the firms to invest more in R&D. The firms in a business group may benefit from related party transactions in the form of loans and investments, especially when the affiliated firms have involvement of a family. This type of inter-firm financial support enables the firms to effectively tackle the unexpected economic shocks through relational debt; ensuring the continuity of R&D investments (David, O'Brien, and Yoshikawa, 2008). On the other hand, standalone firms may not benefit from the related party or inter-firm financial support.

It has been further argued that concentrated ownership, as evident in business group firms, helps to mitigate the agency problem between managers and owners, as the managers are from the family itself. On the other hand, in stand-alone firms, with a large number of minority shareholders, the small and dispersed shareholders have less incentive to monitor the managers and this leads to collective action failures (Hashem and Ugur, 2012). Prior studies provide evidence that due to limited agency problems in business group firms, they spend more on R&D investments (Hill and Snell 1989; Baysinger, Kosnik, and Turk 1991).

On the other hand, the contracting approach investigates how the ownership structure addresses the problem of contracting between various stakeholders in the short-time horizon. According to this approach, the ex-post bargaining power of the stakeholders depends on the ownership structure of a firm (Battaggion and Tajoli 2000; Ugur and Hashem 2012) and hence, this bargaining power influences the allocation of quasi-rents generated by the firm. If the ownership structure helps to reduce the asymmetry in the distribution of power between minority and majority shareholders, then innovation increases. If ownership is concentrated, like in a business group firm, the majority of shareholders would have greater bargaining power over the minority shareholders and then it would be difficult to raise funds for financing of innovation. Thus, the predictions of the agency theory and the contracting theory, in the context of the relationship between corporate governance and innovation, lead to conflicting arguments for business group firms vis-a-vis stand-alone firms.

Aghion et. al. (2002) argues that the effect of product market competition on innovation will be more in firms with ‘satisficing’ managers which are non-profit maximizers. The argument is that the higher product market competition would reduce the flow of rents to firms that have just innovated and hence to remain competitive and solvent, the firm has to make more innovation. This will happen because the satisficing managers have less interest in monetary incentives for personal gain. In an emerging economy, the stand-alone firms would be characterised by satisficing managers, whose primary objective is not profit-maximization, unlike a business group firm. Based on the above discussion we formulate the following two hypotheses:

H9: The higher is the market competition, the stronger is the relationship between corporate governance and innovation in business group firms relative to standalones

H10: The higher is the market competition, the weaker is the relationship between corporate governance and innovation in business group firms relative to standalones

3. Data and Methodology and Variables

The firm-level data of private firms registered with BSE (Bombay Stock Exchange) and NSE (National Stock Exchange) has been extracted from the prowess database managed by the Centre for Monitoring Indian Economy. The firms that have data available for at least one year are included. The firms with greater foreign share have been removed as the key decision on R&D are likely to be influenced by foreign partners. Finally, after eliminating the firms with a greater share of state or central governments, we are left with an unbalanced panel of 777 companies for nineteen years (2001-2019), therefore, making the total number of observations equal to 14763.

As an estimation method, we have used the panel Tobit regression approach . The use of Tobit modelling is appropriate when the dependent variable is censored (Greene 2003). Our dependent variable, R&D intensity, is left-censored at zero. We use the random effect panel Tobit regression model as our major explanatory variables do not change over time (Kennedy 2008). One-year lagged values have been used to avoid possible endogeneity. Our model specifications are as follows:

$$RD_{it}=\sum\beta_k CG_{kit-1}+\sum\lambda_i Controls_{it-1}+\mu_i+\delta_t+\varepsilon_{it} \quad (1)$$

$$RD_{it}=\sum\beta_k CG_{kit-1}+\theta COMP_{it-1}+\sum\lambda_j Controls_{jit-1}+\mu_i+\delta_t+\varepsilon_{it} \quad (2)$$

$$RD_{it}=\sum\beta_k CG_{kit-1}+\theta COMP_{it-1}+\sum\eta_k(CG_{kit-1}\times COMP_{it-1})+\sum\lambda_j Controls_{jit-1}+\mu_i+\delta_t+\varepsilon_{it} \quad (3)$$

$$RD_{it}=\sum\beta_k CG_{kit-1}+\theta COMP_{it-1}+\varphi COMP^2{}_{it-1}+\sum\lambda_j Controls_{jit-1}+\mu_i+\delta_t+\varepsilon_{it} \quad (4)$$

$$RD_{it}=\sum\beta_k CG_{kit-1}+\theta COMP_{it-1}+\varphi COMP^2{}_{it-1}++\sum\eta_k(CG_{kit-1}\times COMP_{it-1})+\sum\lambda_j Controls_{jit-1}+\mu_i+\delta_t+\varepsilon_{it} \quad (5)$$

In the above specifications, the subscripts i and t denote the firm and time respectively. Our dependent variable is R&D intensity. CG represents the corporate governance indicators viz., share held by family (FAM), family CEO/MD (FAMCEO), the dual role of family CEO and chairperson (DUAL) and degree of independence enjoyed by boards of directors (IND). COMP represents the level of product market competition. As control variables, we include some firm characteristics such as the size of the firm (SIZE), age of the firm (AGE), the prior performance of the firm (ROA), leverage (LEV), export intensity (EXP), financial slack (FS), foreign institutional shareholdings (FII), domestic institutional shareholdings (DII). In equations (4) and (5) we include a square term of the COMP to control for the non-linear

2. We have also estimated the Tobit model after dropping outliers and system-GMM estimation for testing robustness our results. The results from these estimations are supported by our findings from Tobit estimation suggesting robustness of the results. We have not reported panel GMM and Tobit (after dropping outliers) estimation results for the sake of brevity.

relationship between market competition and innovation (Aghion et al. 2005). We estimate all the five specifications including a dummy variable for group affiliation (GROUP) separately. The coefficients μ, δ and ε capture industry fixed effects, time fixed effects and random disturbances.

3.1 Variable construction

Dependent variable: The dependent variable, R&D Intensity (RD) is the main dependent variable in our model and is measured by the ratio of R&D expenditure and aggregate sales. The R&D intensity is an input variable and is extensively treated as a proxy for technological innovations happening within the firms. As R&D investments may or may not fully reflect innovations, some of the studies prefer to use other output measures of innovation such as patent count or change in Total Factor Productivity (TFP). However, these output-based indicators may also be inadequate to represent innovative activities (Singh and Chakraborty 2021). Our dependent variable, as an input variable, is more likely to capture the innovative efforts of the firms irrespective of any technological or commercial benefit. Therefore, we consider R&D as a better indicator of 'intent to innovate' than other output-based measures. It should also be noted here that R&D is considered highly risky and uncertain (Gupta, Wilemon, and Atuahene-Gima 2000), therefore making the output-based indicators a relatively less precise measure of 'intent to innovate' or 'innovative efforts'. This observation is important in the context of this study considering the behavioural analysis of family firms focus on how they behave instead of how they perform.

Independent variables: The independent variables in the model represent various aspects of corporate governance and product market competition. In particular, the following variables are used: (1) *Family shareholding (FAM)* is defined as the percentage of shares held by Indian individuals and Hindu undivided families (HUF) as promoters. The literature suggests that concentration of ownership may affect the innovative activities of the firms (see

Matzler et al. 2015; Ashwin, Krishnan, and George 2015). (2) *Family CEO/MD (FAMCEO)*: The role of CEO as a determinant of innovative efforts of the firms' has also been recognised extensively (Diéguez-Soto, Garrido-Moreno, and Manzaneque 2018; Manzaneque, Diéguez-Soto, and Garrido-Moreno 2018; Huybrechts, Voordeckers, and Lybaert 2013). Following Ashwin, Krishnan, and George (2015), we assume that the CEO/MD belongs to the family owning the firm when the CEO/MD of the firm is also a promoter. The variable takes the value equal to 1 when CEO/MD is from family, and 0 otherwise. (3) *Family CEO-chairperson duality (DUAL)* variable has been incorporated to test the impact of family control on investments in innovations when both the CEO/MD and chairperson belong to the controlling family. The literature suggests that the dual presence of the CEO and chairperson enhance the impact of family control over the firms' strategic decisions such as R&D (see Baliga, Moyer, and Rao 1996; Li and Yang 2019). The dummy variable takes the value equal to 1 when both CEO/MD and the chairperson are the promoter shareholders. (4) *Board Independence (IND)* also be an important factor that can influence the extent to which firms' may invest in the R&D. The degree of governing board's independence is measured as the ratio of independent directors to the total number of directors present in the board.

Additionally, interaction terms of some of the aforesaid variables (FAM, FAMCEO and DUAL) with the level of product market competition has been introduced in the model. The competition variable is also included separately considering it may provide an incentive to the firms to invest in R&D (For better understanding, we have resorted to measuring the product market competition using two different measures i.e. HHI *(Herfindahl-Hirschman Index)* and PCM (Price-cost Margin). HHI is calculated as a sum of the square of the market share of each firm at 3-digit National Industrial Classification (NIC)-2008. Mathematically, it can be written as follows:

$$HHI_{mt} = \sum_{i=1}^{n} S_{it}^{2} \qquad where, S_{it} = \frac{sales_{it}}{\sum_{i=1}^{n} sales_{it}}$$

Price Cost Margin (PCM) represents price competition and is calculated as follows:

$$\text{PCM} = \frac{total\ output - total\ inputs - payroll}{total\ output}$$

The values of HHI and PCM lie between 0 and 1. If the value is 0, perfect competition is considered to be prevailing, whereas, if it is 1, it signifies a monopoly in the market. By definition, HHI measures competition from domestic firms in terms of their relative shares in the market. It does not take into consideration competition from foreign firms. However, PCM, as the difference between price and marginal cost, reflects the overall price competition that a firm faces. To convert HHI and PCM from explicit measures of market concentration into measures of competition, we subtract them from one. It should be noted that for a simpler interpretation of the results throughout this paper, the product market competition measured using HHI and PCM index is referred to as DCOMP (domestic competition) and PCOMP (price competition) respectively. Furthermore, a squared term for competition variable(s) is also included to control for a possible non-linear relationship between innovation and product market competition (see Tingvall and Poldahl 2006; Aghion et al. 2005; Michiyuki and Shunsuke 2013).

Apart from the aforementioned variables, some other controls have been used in the model as suggested by Ashwin, Krishnan, and George (2015): *Size of the firm (SIZE)* may be an important determinant of its R&D investments (Mowery 1983). A larger firm may be financially more capable and resourceful to invest in R&D. Contrary to this, it can also be argued that smaller firms have indivisibilities in favour of their smaller scale, providing them with greater scope to grow faster. The size of the firm in our model has been measured as the log of the deflated value of reported revenue from sales. *Age of the firm (AGE)* may also affect their R&D investments. Coad et al. (2016) argue that younger firms grow faster as they grow older. The age of the firm has been calculated by taking the log of the values obtained by subtracting the incorporation year from the year to which the data belongs. Return on assets (ROA), in our model, is a proxy for the prior performance of the firm. The performance in the past is likely to encourage and assist the firm to invest more in R&D. On the other hand, if performance is poor, the firms' may exhibit rigid and conservative behaviour towards strategic R&D investments (Ahuja, Lampert, and Tandon 2008). The variable is measured as the ratio of profit before depreciation, interest, tax and amortisation (PBDITA) and total assets. *Leverage (LEV)* indicates the financial situation of the firm. It is calculated as the ratio of debt to equity of the firm. The firms with a higher debt to equity ratio may be more concerned about paying off the debt using current cash flow instead of investing in R&D (Munari, Oriani, and Sobrero 2010). *Exports intensity (EXP)* is defined as a ratio of exports and aggregate sales. The technological spillovers from the foreign markets and the need to compete with other multinationals provide the exporting firms with an incentive to learn and invest in technological up-gradation. Therefore, it can be argued that the firms with a higher export share in the total output are likely to invest more in R&D (Solomon and Shaver 2005; Neves, Teixeira, and Silva 2016). *Financial slack (FS)* is another important determinant of industrial R&D. The current ratio is a liquidity ratio that is used to measure a company's ability to meet its short-term obligations, i.e. to pay off its short-term liabilities. A ratio of current assets divided by current liabilities measures the adequacy of the company's short-term assets to meet its short-term liabilities. A ratio below one implies inadequacy and a ratio just above one would indicate a "just-about" adequate ability to meet current liabilities. But, a ratio that is much above one would indicate too much of a short-term asset on hand that could be deployed for better long-term use. It has been established that financial adequacy in the short-run allows the firms to invest more in discretionary strategic investments like

R&D (see Kim, Kim, and Lee 2008; Ashwin, Krishnan, and George 2016). *Foreign institutional shareholding (FII)* serves as active monitors, provides the firms' with insurance in case of innovation failures, and encourage technological spillovers from high-innovation economies (Luong et al. 2017). The foreign investors, in this way, are likely to boost up the innovative efforts of the firms. In our model, the percentage of promoter shares held by foreign institutional investors is used as a control variable. *Domestic institutional shareholding (DII)* defined as the percentage of common shares held by domestic institutional investors is another important control variable in the model. It has been observed that institutional ownership acts as a pressure resistance for managers and result in greater investments in R&D (Bushee 1998). Finally, a dummy variable *Group-affiliation (GROUP)* takes the value equal to 1 when the firm is affiliated to a business group, and 0 if the firm is a standalone firm. The literature observes group affiliation as an important determinant of innovative activities of the firms (see Guzzini and Iacobucci 2014; Belenzon and Berkovitz 2010)

4. Preliminary Observations

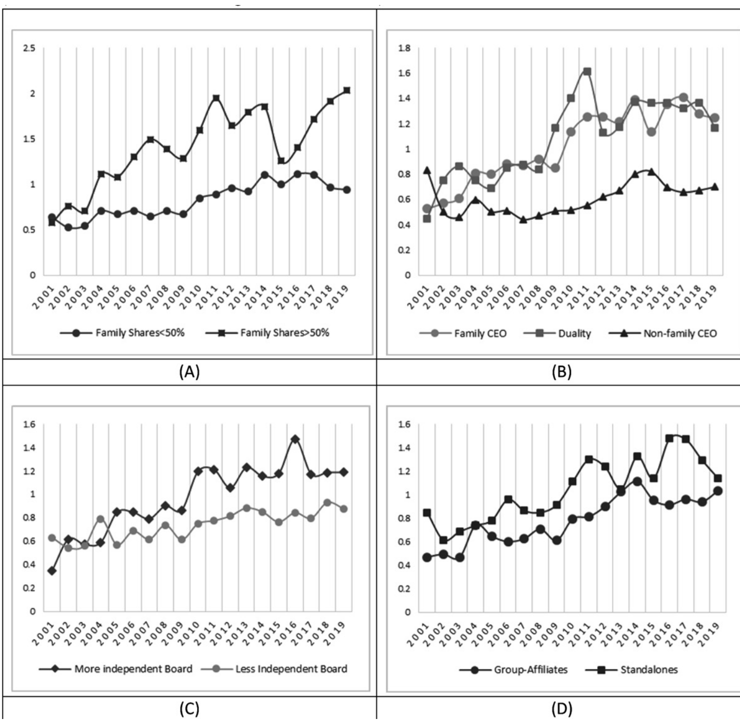
The preliminary observations reveal that corporate governance indicators and other firm characteristics of interest, as defined in the previous section, may have implications for firms' decision to invest in R&D. Figure 4.1, for instance, depicts the R&D intensity of different sub-groups of firms.

Figure 4.1A shows that throughout our study period, the firms with highly concentrated family ownership (percentage of shareholding greater than 50 percent) increasingly invested much more on R&D as a share of their output than the firms with less concentrated family ownership (percentage of shareholding less than 50 percent). The ratio increased approximately four times in the case of the former during the last two decades, whereas the latter witnessed limited growth in R&D intensity. The firms managed by CEOs or collectively by CEO-chairperson from the owner-family also invest more in innovations than firms managed by non-family CEOs (Figure 4.1B). It can be observed that non-family CEOs have shown negligible improvement in terms of making the firms more R&D intensive.

The independent board is another characteristic, that may play an important role in determining the innovative efforts of the firms. Figure 4.1C shows that firms with a greater ratio of independent directors[3] invest more into R&D activities. Finally, standalone firms are found to be more R&D intensive than group-affiliated firms to some extent (see Figure 4.1D). The observations indicate that family involvement, board characteristics and group affiliation may be very important determinants of innovative activities of the firms.

Figure 4.1: R&D-intensity of various sub-groups of the manufacturing firms

(Source: Authors' calculations using CMIE-Prowess data)



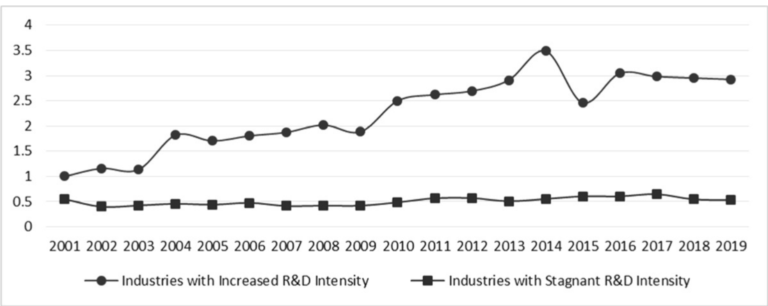
Note: x-axis and y-axis denote 'Time' and 'Average R&D-intensity' respectively

3. In order to define the board of directors as a more/less independent entity, we use median value from our sample. The exercise allows us to define the board as more independent if the ratio of independent directors to total directors is equal to or greater than 0.5.

It is important to mention that only a few industries within the manufacturing sector of India have turned out to be increasingly R&D intensive. The R&D intensity of the others have remained largely stagnant or the improvement is extremely limited. The industries that witnessed consistent growth in the R&D industry are pharmaceuticals, computer/electronic manufacturing and manufacturing of motor vehicles/trailers. The average growth trend within these three industries and others with stagnant R&D intensity has been depicted in Figure 4.2.

Figure 4.2: Average R&D-intensity of manufacturing industries with increased and stagnant R&D-intensity

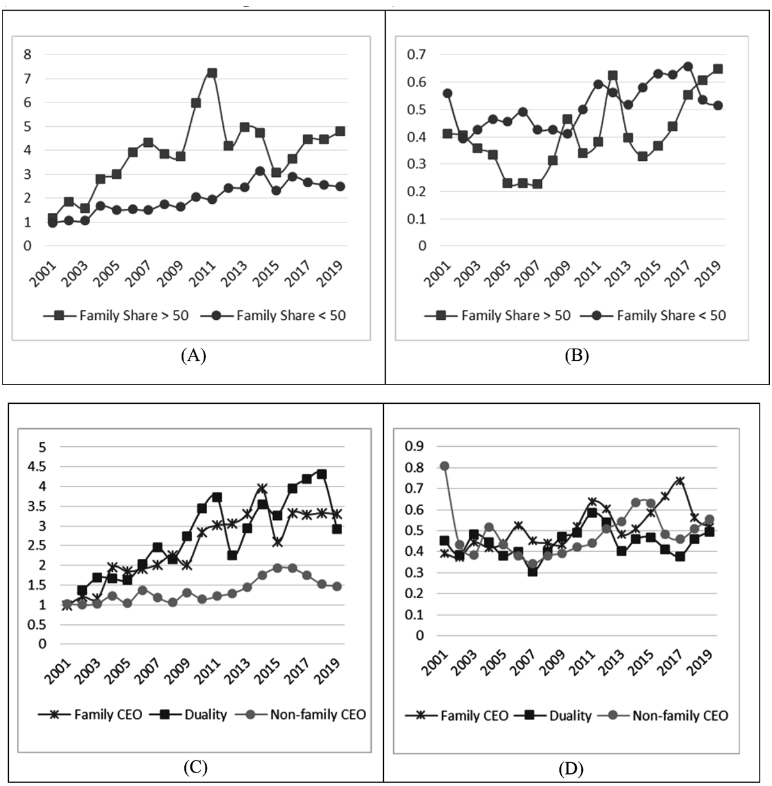
(Source: Authors' calculations using CMIE-Prowess data)



Considering that the industries that experienced rising R&D intensity are more research-oriented and increasingly more investments in R&D may be required for the firms to survive increasing competition, the family firms within these industries may opt for different strategic investments than the family firms operating in industries where R&D intensity remained stagnant. A preliminary examination reveals that in the case of R&D intensive industries, the firms with concentrated family ownership have consistently invested more in R&D than the firms with diluted family ownership (Figure 4.3A).

Figure 4.3: Average R&D intensity of various sub-groups of manufacturing firms

(Source: Authors' calculations using CMIE-Prowess data)

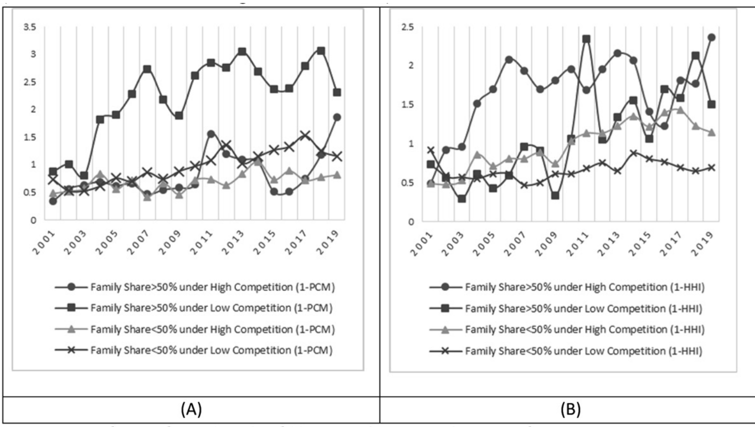


Contrary to this, in the sample of stagnant R&D intensity industries, the average R&D intensity of firms with concentrated family ownership seems to be less than the firms with diluted family ownership (Figure 4.3B). Similarly, in the case of more R&D intensive industries, firms with family CEOs, CEO-chairperson duality increasingly invest much more in R&D as a share of total output than the firms with non-family CEOs (Figure 4.3C). Nonetheless, any definitive pattern is not conspicuous in the case of the stagnant R&D industries (Figure 4.3D).

Interestingly, the factors we discussed seem to be behaving differently under varying levels of product market competition (see Figure 4.4, Figure 4.5, Figure 4.6 and Figure 4.7).

Figure 4.4: R&D-intensity of the firms with more and less concentrated family ownership under high and low product market competition levels

(Source: Authors' calculations using CMIE-Prowess data)



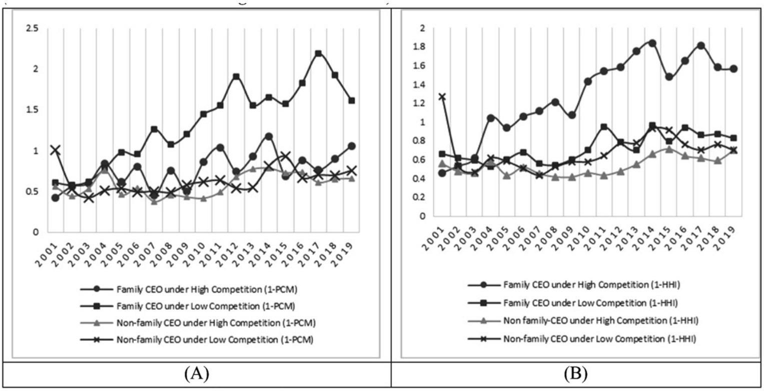
Note: x-axis and y-axis denote 'Time' and 'Average R&D-intensity' respectively

Figure 4.4A noticeably exhibits that family-owned firms with concentrated shares have increasingly invested much more under lower price competition. Firms with family-share less than 50 percent also perform somewhat better under lower price competition. Though the high competition seems to be a limiting factor that restricts the R&D investments of all the firms, the influence of competition appears to be much stronger in the case of firms with concentrated family ownership. Surprisingly, we find contrasting observations when we use DCOMP as the measure of product market competition (Figure 4.4B). The firms perform better in terms of greater investments in R&D as a share of output under high competition. Nonetheless, the impact of competition still seems to be stronger in the case of family firms with higher shareholdings. The observations are largely suggesting that firms with concentrated family ownership invested more in R&D when the price competition was low, whereas domestic market competition encouraged them when it was higher.

The graphical analysis of R&D intensity in the context of family control over management provides us with somewhat similar results. The firms facing lower price competition and controlled by family-CEOs increased R&D-intensity manifolds during the study period (Figure 4.5A). The firms with non-family CEOs, however, witnessed a negligible increase in R&D share. After replacing the measure of competition with DCOMP, it is found that firms with family CEO did better under higher product market competition (Figure 4.5B).

Figure 4.5: R&D-intensity of the firms controlled by family/non-family-CEOs under high and low product market competition levels

(Source: Authors' calculations using CMIE-Prowess data)



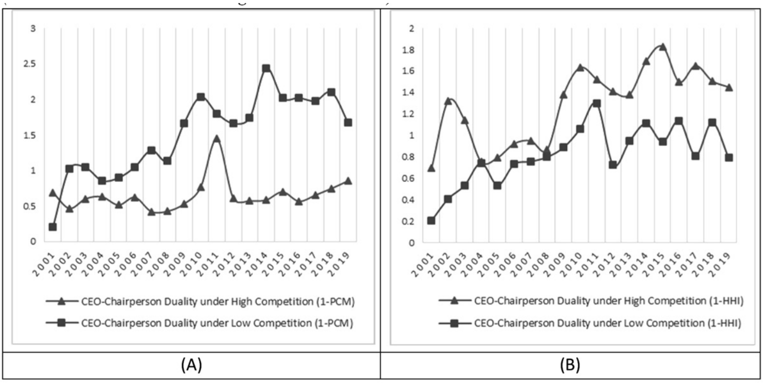
Note: x-axis and y-axis denote 'Time' and 'Average R&D-intensity' respectively

Figure 4.6A and Figure 4.6B suggests that family-controlled firms perform differently under different levels of competition even when CEO-chairperson duality is taken into account. The results once again are contingent upon the measure of competition.

Finally, we attempt to observe the pattern of change in R&D intensity of the group-affiliated and standalone firms operating under different competitive environments. The data suggests standalone firms perpetually invest more in R&D than their counterpart group-affiliated firms, however, the increase was notable when the price competition was low (Figure 4.7A), or domestic market competition was high (Figure 4.7B).

Figure 4.6: R&D-intensity of the firms controlled by family CEOs and chairperson duality under high and low product market competition levels

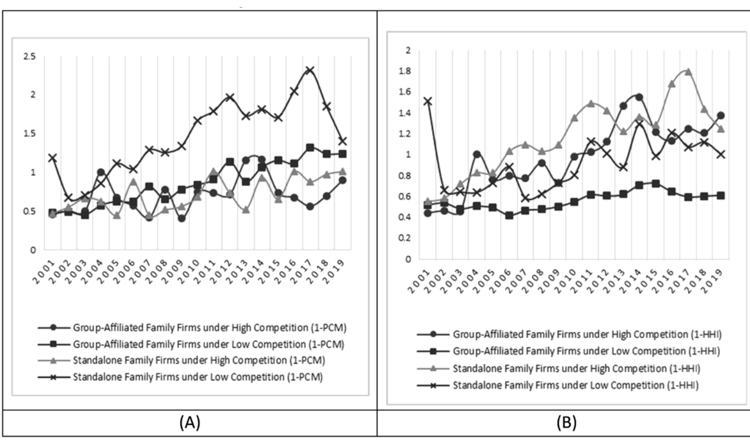
(Source: Authors' calculations using CMIE-Prowess data)



Note: x-axis and y-axis denote 'Time' and Average R&D-intensity respectively

Figure 4.7: R&D-intensity of the group-affiliated and standalone firms under high and low product market competition levels

(Source: Authors' calculations using CMIE-Prowess data)



Note: x-axis and y-axis denote 'Time' and Average R&D-intensity respectively

The preliminary observations suggest that corporate governance is an important determinant of industrial innovations. Additionally, the level of product market competition seems to play a moderating role in the determination of the relationship between corporate governance and innovations. The initial graphical analysis requires rigorous statistical testing which will be done in the subsequent section.

5. Empirical Results

As discussed earlier, the Panel Tobit regression approach has been used to test our hypothesis and the econometric results are discussed in this section[4]. All the tables present the estimation outcomes in a systematic way to observe how the inclusion or exclusion of various independent variables related to corporate governance and product market competition affect the dependent variable in our model.

Model 1.1 of Table 5.1 estimates the equation (1) and finds that the factors representing family ownership and control over management are statistically significant. The higher ratio of independent directors is also significantly positive suggesting a more independent board allows the firms to put in greater financial efforts towards R&D. Among the control variables, size of the firms, exports, and financial slack are found to be positively associated with R&D-intensity, whereas, the share of domestic institutional promoters and group-affiliation affect the R&D-intensity of the firms' negatively. Other control variables such as age, ROA, and FII are statistically insignificant. Model 1.2 includes the domestic competition variable (DCOMP) as mentioned in equation (2) and finds domestic competition to

4. It should be noted that the interpretation of Tobit estimation results is not as straight forward as OLS. Unlike OLS regression, the coefficients in Tobit analysis do not represent a unit change in regressand for a given unit change in a regressor. The actual values of coefficients depend on the probability that latent variable in the model is actually observed. Considering that the probability that latent variable is observed lies between zero and one, the product of each slope coefficient multiplied by this probability will be smaller than the slope coefficient (see Gujarati 2015; Wooldridge 2015). However, the direction of impact (positive/negative) remains unchanged given that the probability is always positive.

be adversely affecting the R&D investments of the firms. Other variables largely remain unchanged. Therefore, the results from Model 1.1 support our hypotheses H1, H3 and H5 and conclusively suggest that theory of stewardship and SEW is valid in the Indian context.

Model 1.3, Model 1.4 and Model 1.5, in order to test equation (3), respectively include the interaction terms between the domestic competition variable and other variables representing corporate governance namely family shareholding, family-CEO and CEO-chairperson duality. The results provide evidence that there may exist a moderating effect of market competition on the corporate governance indicators viz. FAM and FAMCEO in influencing the R&D investments of the firms. This implies that the marginal effect of a greater competition level on the R&D intensity of the firm is greater when the ownership is concentrated or the CEO belongs to the family. In other words, under higher domestic competition, as family ownership or degree of family control increases, the R&D intensity of the firm also rises. It is interesting to find that the explicit impact of domestic competition is negative on the innovative efforts of the firms yet it encourages the firms with concentrated ownership/control to invest more in R&D. The interaction between competition and CEO-chairperson duality, however, is statistically insignificant. Model 1.6 finds similar results when all the interaction variables are included. Overall, Model 1.3, 1.4 and 1.6 support our hypothesis H7 suggesting corporate governance and market competition are complementary. Thereafter, a variable defined as the square of the competition variable is incorporated in the model to test the non-linear relationship between innovations and competition, (see Model 1.7). The estimation finds the variable insignificant suggesting the relationship is likely to be linear. Finally, Model 1.8 present the estimation results after incorporating all the independent variables. The value of Wald chi-square statistic is highest in Model 1.8 indicating that it is the best model.

Likewise, Table 5.2 tests all the models after replacing the measure of competition in the model with PCOMP. The results confirm the significance of corporate governance variables. However, contrary to the results we found in Table 5.1, the multiplicative term between FAM and PCOMP is insignificant, whereas, it is significantly negative in the case of other measures of corporate governance. A significant non-linear relationship has also been observed between price competition and innovations. It should be noted that the estimations from Table 5.1 and Table 5.2 corroborate the findings of the erstwhile Indian studies and additionally suggest that the product market competition may complement the concentrated corporate governance. However, the observation is contingent upon how the competition variable is defined in the model.

Now, it can be argued that the Indian manufacturing industry has experienced fragmented growth. Certain sub-sectors have grown relatively faster, and have significantly increased R&D intensity in the recent decades than other sub-sectors. Our data shows that R&D intensity has increased significantly in sub-sectors such as pharmaceuticals, computer/electronic manufacturing and manufacturing of motor vehicles/trailers. The rest of the manufacturing sub-sectors have experienced a low and almost stagnant level of R&D intensity. In order to observe whether the family firms have exhibited stewardship attitude in aforesaid two different sets of manufacturing industries, we estimate the model separately for the sample of firms operating in sectors that have witnessed increasing R&D intensity during the study period and the rest of the manufacturing sectors where R&D intensity remained largely stagnant. It has been found that in the industries with increased R&D intensity, the relationship between concentrated family ownership and innovation is significantly positive (Table 5.3 and Table 5.5). Little evidence of an association between the two variables has been observed in the case of R&D stagnant industries (Table 5.4 and Table 5.6). The statistical evidence further suggests that interaction between CG and domestic competition (DCOM) is significant in case of high as well as less R&D intensive sub-sectors. However, Table 5.6 shows that the significant moderating impact of price competition (PCOMP) on CG is absent for sub-sectors with low and stagnant manufacturing sub-sectors. The results suggest that stewardship theory, earlier found to be validated in the overall Indian manufacturing industry (Lodh, Nandy, and Chen 2014) and Pharmaceutical industry (Ashwin, Krishnan, and George 2015), is only applicable in the case of select sub-sectors where R&D intensity has increased in recent decades.

Finally, we estimate the model using data on group-affiliated and standalone firms separately to test the hypotheses H9 and H10 (see Table 5.7 to Table 5.10). In contrast with our findings on the entire manufacturing sector, the study of the sample containing group-affiliated firms shows that concentrated family ownership is negatively associated with R&D intensity (see Table 5.7 and Table 5.9). The findings are in contrast with (Lodh, Nandy, and Chen 2014). The family-CEO and CEO-chairperson duality also seem to be insignificant factors. Moreover, the results suggest that the interaction between family ownership and domestic competition is negative (Table 5.7).

Table 5.1: Panel Tobit estimation using aggregate sample (DCOMP as measure of competition)

Variables	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5	Model 1.6	Model 1.7	Model 1.8
FAM	0.021*** (0.001)	0.023*** (0.0011)	0.0218*** (0.0045)	-0.0019 (0.001)	0.0002 (0.002)	0.0234*** (0.0045)	-0.0002 (0.001)	0.023*** (0.0045)
FAMCEO	0.055*** (0.009)	0.0554** (0.022)	0.0531 (0.092)	0.074** (0.031)	0.057 (0.092)	.073*** (0.014)	0.055 (0.092)	1.048*** (0.385)
DUAL	0.018*** (0.006)	0.019*** (0.006)	-0.015 (0.036)	-0.0195 (0.0361)	0.134*** (0.008)	0.189 (0.199)	-0.018 (0.036)	0.186 (0.199)
IND	0.781*** (0.056)	0.785*** (0.056)	0.787*** (0.056)	0.784*** (0.056)	0.786*** (0.056)	0.787*** (0.056)	0.785*** (0.056)	0.786*** (0.056)
DCOMP		-1.453*** (0.266)	-1.027*** (0.279)	-2.081*** (0.393)	-1.42*** (0.268)	-1.817*** (0.396)	-1.108 (0.787)	-1.323* (0.756)
FAM*DCOMP			1.026*** (0.052)			1.028*** (0.053)		1.028*** (0.052)
FAMCEO*DCOMP				0.915** (0.421)		1.245*** (0.427)		1.262*** (0.428)
DUAL*DCOMP					-0.177 (0.225)	-0.237 (0.227)		-0.234 (0.227)
(DCOMP)^2							-0.351 (0.754)	-0.514 (0.755)
Size	0.0717*** (0.019)	0.076*** (0.019)	0.0744*** (0.019)	0.077*** (0.019)	0.076*** (0.019)	0.074*** (0.019)	0.076*** (0.019)	0.075*** (0.019)
Age	0.117 (0.11)	0.121 (0.13)	0.1046 (0.131)	-0.131*** (0.013)	0.120 (0.17)	0.116 (0.12)	0.121 (0.11)	0.116*** (0.016)
ROA	-0.054 (0.037)	-0.049 (0.037)	-0.0515 (0.037)	-0.048 (0.037	-0.049 (0.037)	-0.0503 (0.036)	-0.049 (0.037)	-0.051 (0.036)
LEV	0.0001 (0.0002)	0.00011 (0.00028)	0.000108 (0.00028)	0.00011 (0.00028)	0.00011 (0.0002)	0.00011 (0.0002)	0.00011 (0.0002)	0.00011 (0.0002)
EXP	0.05*** (0.008)	0.036*** (0.0086)	0.036*** (0.008)	0.035*** (0.008)	0.036*** (0.008)	0.036*** (0.008)	0.036*** (0.008)	0.037*** (0.008)
FS	0.047*** (0.01)	0.036*** (0.012)	0.037*** (0.012)	0.037*** (0.013)	0.036*** (0.0011)	0.033*** (0.016)	0.036*** (0.011)	0.037*** (0.011)
FII	-0.0002 (0.0017)	-0.00028 (0.0017)	-0.0005 (0.0017)	-0.00023 (0.0017)	-0.0002 (0.0017)	-0.00046 (0.0017)	-0.00026 (0.0017)	-0.0004 (0.0017)
DII	-0.0017* (0.0010)	-0.0019* (0.0011)	-0.0021* (0.0011)	-0.0019* (0.0011)	-0.0019* (0.0011)	-0.0021** (0.0011)	-0.0019* (0.0011)	-0.0021** (0.0011)
GROUP	-0.054*** (0.011)	-0.052** (0.021)	0.0535 (0.1005)	0.0477 (0.1005)	0.052 (0.10)	-0.0479*** (0.003)	0.052 (0.1006)	-0.048*** (0.005)
Constant	-0.475* (0.256)	0.89** (0.358)	0.577* (0.293)	1.423*** (0.434)	0.868** (0.359)	1.251** (0.434)	0.878** (0.359)	1.24*** (0.435)
Wald Chi-Square	599.94	630.55	656.61	635.82	631.2	666.63	630.77	667.10
Log-likelihood	-26188.6	-26173.7	-26161.3	-26171.43	-26173.48	-26156.85	-26173.67	-26156.6

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.2: Panel Tobit estimation using aggregate sample (PCOMP as measure of competition)

Variables	Model 2.1	Model 2.2	Model 2.3	Model 2.4	Model 2.5	Model 2.6	Model 2.7	Model 2.8
FAM	0.021*** (0.001)	0.011*** (0.0014)	0.001 (0.0018)	-0.016*** (0.0011)	0.019*** (0.0019)	0.026*** (0.0018)	0.029*** (0.0039)	0.015*** (0.0019)
FAMCEO	0.055*** (0.009)	0.052*** (0.09)	0.053** (0.012)	-0.096 (0.121)	0.052 (0.092)	0.137*** (0.012)	0.049 (0.092)	0.143 (0.121)
DUAL	0.018*** (0.006)	0.021*** (0.0036)	0.022*** (0.0041)	0.025 (0.0362)	0.214** (0.099)	0.256** (0.101)	-0.021 (0.036)	0.225** (0.101)
IND	0.781*** (0.056)	0.783*** (0.056)	0.783*** (0.056)	0.785*** (0.056)	0.781*** (0.054)	0.783*** (0.056)	0.781*** (0.056)	0.782*** (0.056)
PCOMP		0.142* (0.079)	0.111 (0.094)	-0.067 (0.134)	0.206*** (0.083)	-0.072 (0.139)	1.306*** (0.301)	1.033*** (0.318)
FAM*PCOMP			0.0018 (0.0031)			0.0013 (0.0031)		0.0021 (0.0031)
FAMCEO*PCOMP				-0.297* (0.153)		-0.379** (0.157)		-0.387*** (0.157)
DUAL* PCOMP					-0.425*** (0.166)	-0.511*** (0.169)		-0.45*** (0.17)
(PCOMP)^2							-1.168*** (0.292)	-1.13*** (0.293)
Size	0.0717*** (0.019)	0.0561*** (0.0217)	0.057*** (0.021)	0.053** (0.021)	0.051** (0.021)	0.048** (0.022)	-0.0074 (0.026)	-0.011 (0.027)
Age	0.117 (0.11)	0.126 (0.131)	0.127 (0.131)	0.142 (0.13)	0.122 (0.131)	0.141 (0.131)	0.129 (0.131)	0.146 (0.131)
ROA	-0.054 (0.037)	-0.053 (0.037)	-0.053 (0.037)	-0.052 (0.037)	-0.052 (0.037)	-0.052 (0.037)	-0.053 (0.037)	-0.053 (0.037)
LEV	0.0001 (0.0002)	0.0001 (0.0002)	0.00011 (0.0003)	0.0001 (0.0003)	0.00021 (0.0002)	0.0001 (0.0002)	0.00011 (0.0002)	-0.00011 (0.0003)
EXP	0.05*** (0.008)	0.034*** (0.008)	0.034*** (0.0087)	0.034*** (0.0087)	0.034*** (0.008)	0.033*** (0.008)	0.032*** (0.0087)	0.031*** (0.008)
FS	0.047*** (0.01)	0.04*** (0.011)	0.05*** (0.0012)	0.04*** (0.0011)	0.04*** (0.001)	0.04*** (0.0015)	0.05*** (0.0012)	0.05*** (0.014)
FII	-0.0002 (0.0017)	-0.00023 (0.0017)	-0.00017 (0.0077)	-0.0002 (0.00174)	-0.00028 (0.0017)	-0.00021 (0.0016)	-0.00032 (0.0013)	-0.00027 (0.0012)
DII	-0.0017* (0.0010)	-0.0019* (0.0011)	-0.00188* (0.0010)	-0.00191* (0.0011)	-0.00201* (0.0011)	-0.00193* (0.0011)	-0.0021** (0.0012)	-0.0022** (0.0012)
GROUP	-0.054*** (0.011)	0.063 (0.101)	-0.063*** (0.008)	0.061 (0.101)	0.065 (0.101)	0.061 (0.1007)	-0.085 (0.013)	0.081 (0.101)
Constant	-0.475* (0.256)	-0.515** (0.257)	-0.510** (0.257)	-0.42* (0.261)	-0.522** (0.257)	-0.403 (0.261)	-0.555** (0.257)	-0.431* (0.261)
Wald Chi Squ.	599.94	602.98	603.22	606.62	610.27	616.6	619.51	631.95
Log-likelihood	-26188.6	-26187.1	-26186.8	-26185.1	-26183.7	-26180.6	-26179.1	-26173.1

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.3: Panel Tobit estimation using a sample of highly R&D intensive industries (DCOMP as measure of competition)

Variables	Model 3.1	Model 3.2	Model 3.3	Model 3.4	Model 3.5	Model 3.6	Model 3.7	Model 3.8
FAM	0.07*** (0.005)	0.06*** (0.0058)	0.169*** (0.034)	0.06*** (0.0058)	0.07*** (0.008)	0.173*** (0.036)	0.07** (0.008)	0.173*** (0.036)
FAMCEO	1.21* (0.717)	1.2643* (0.724)	1.213*** (0.715)	6.32* (3.47)	1.22* (0.72)	8.66** (3.59)	1.24* (0.71)	8.5** (3.52)
DUAL	0.321* (0.169)	0.326* (0.168)	0.297* (0.167)	0.325* (0.168)	-1.95 (1.104)	-2.776 (1.11)	-0.325 (0.168)	2.79** (1.12)
IND	0.33*** (0.034)	0.261*** (0.04)	0.362*** (0.033)	0.265*** (0.036)	0.272*** (0.031)	0.393*** (0.032)	0.28*** (0.031)	0.39*** (0.035)
DCOMP		-1.13*** (0.11)	0.96 (1.77)	0.84 (3.62)	-1.89*** (0.05)	1.58** (0.43)	-12.6 (9.01)	2.98 (2.39)
FAM*DCOMP			0.193*** (0.041)			0.208*** (0.041)		0.206*** (0.042)
FAMCEO*DCOMP				1.78 (3.88)		1.59** (0.62)		1.45*** (0.09)
DUAL*DCOMP					1.87 (1.26)	2.86** (1.27)		2.88** (1.28)
(DCOMP)^2							6.33 (6.64)	1.88 (6.76)
Size	1.27*** (0.262)	1.293*** (0.266)	1.253*** (0.264)	1.270*** (0.267)	1.321*** (0.267)	1.260*** (0.265)	1.263*** (0.267)	1.253*** (0.26)
Age	0.45*** (0.006)	0.38*** (0.009)	0.08*** (0.005)	0.32*** (0.006)	0.39*** (0.006)	0.91*** (0.06)	0.3*** (0.011)	0.98*** (0.13)
ROA	-0.72*** (0.071)	-0.828*** (0.011)	-0.798*** (0.071)	-0.65*** (0.041)	-0.84*** (0.01)	-0.773*** (0.04)	-0.795*** (0.03)	-0.765*** (0.11)
LEV	0.087** (0.035)	0.084** (0.039)	0.093*** (0.039)	0.084** (0.039)	0.087** (0.039)	0.094** (0.039)	0.085** (0.034)	0.094** (0.029)
EXP	0.091** (0.038)	0.092** (0.037)	0.098*** (0.037)	0.093** (0.037)	0.092** (0.037)	0.099*** (0.037)	0.088** (0.038)	0.098*** (0.037)
FS	0.312*** (0.069)	0.323*** (0.069)	0.317*** (0.068)	0.322*** (0.069)	0.321*** (0.069)	0.317*** (0.068)	0.323*** (0.069)	0.317*** (0.068)
FII	0.0073 (0.011)	0.0091 (0.011)	0.0062 (0.011)	0.0093 (0.011)	0.0087 (0.011)	0.0057 (0.011)	0.0095 (0.013)	0.0058 (0.011)
DII	-0.004 (0.0075)	-0.002 (0.0075)	-0.005 (0.0075)	-0.002 (0.0075)	-0.002 (0.0075)	-0.005 (0.0075)	-0.002 (0.0075)	-0.005 (0.0075)
GROUP	0.771 (0.703)	0.660 (0.716)	0.841 (0.704)	0.684 (0.72)	0.659 (0.719)	0.89 (0.71)	0.741 (0.717)	0.911 (0.712)
Constant	-4.34*** (1.18)	-0.76 (1.07)	-4.84** (1.89)	-5.11 (3.38)	0.0068 (1.74)	-10.43*** (3.52)	1.744 (3.13)	-9.57** (4.76)
Wald Chi-Square	221.96	231.94	256.5	233.97	234.46	265.49	233.02	265.62
Log-likelihood	-4540.66	-4536.36	-4525.53	-4535.25	-4535.25	-4521.32	-4535.9	-4521.29

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.4: Panel Tobit estimation using sample of less R&D intensive industries (DCOMP as measure of competition)

Variables	Model 4.1	Model 4.2	Model 4.3	Model 4.4	Model 4.5	Model 4.6	Model 4.7	Model 4.8
FAM	-0.0003 (0.0013)	-0.0001 (0.0013)	0.0112** (0.0052)	-0.0008 (0.0013)	-0.0005 (0.0013)	0.015*** (0.0052)	-0.0009 (0.0013)	0.015*** (0.0052)
FAMCEO	-0.026 (0.086)	-0.014 (0.085)	-0.019 (0.086)	-1.42*** (0.371)	-0.015 (0.085)	-1.59*** (0.379)	-0.019 (0.086)	-1.59*** (0.37)
DUAL	0.0098 (0.038)	0.011 (0.038)	0.011 (0.038)	0.0103 (0.033)	-0.15 (0.233)	-0.041 (0.23)	0.0121 (0.038)	-0.023 (0.23)
IND	0.0102 (0.056)	0.0082 (0.056)	0.0099 (0.056)	0.0066 (0.056)	0.0072 (0.055)	0.0085 (0.056)	0.0113 (0.056)	0.0115 (0.056)
DCOMP		-0.97*** (0.22)	-0.76*** (0.23)	-1.92*** (0.32)	-1.01*** (0.22)	-1.76*** (0.33)	-2.05*** (0.74)	-2.78*** (0.78)
FAM*DCOMP			0.013** (0.005)			0.017*** (0.006)		0.017*** (0.006)
FAMCEO*DCOMP				1.61*** (0.41)		1.807*** (0.42)		1.82*** (0.42)
DUAL*DCOMP					0.19 (0.25)	0.05 (0.26)		0.037 (0.26)
(DCOMP)^2								0.891 (0.618)
Size	-0.44*** (0.04)	-0.44*** (0.047)	-0.44*** (0.043)	-0.43*** (0.047)	-0.44*** (0.047)	-0.44*** (0.047)	-0.44*** (0.04)	-0.43*** (0.04)
Age	0.75*** (0.13)	0.72*** (0.13)	0.73*** (0.13)	0.72*** (0.13)	0.72*** (0.13)	0.73*** (0.13)	0.72*** (0.13)	0.72*** (0.13)
ROA	-0.373*** (0.11)	-0.35*** (0.113)	-0.36*** (0.113)	-0.344*** (0.112)	-0.357*** (0.113)	-0.349*** (0.112)	-0.359*** (0.130)	-0.35*** (0.11)
LEV	0.00005 (0.0002)	0.00005 (0.0002)	0.00007 (0.0002)	0.000012 (0.0002)	0.00003 (0.0002)	0.000011 (0.0002)	0.00001 (0.0002)	0.00002 (0.0002)
EXP	0.040*** (0.018)	0.039*** (0.010)	0.039*** (0.011)	0.038*** (0.012)	0.039*** (0.011)	0.039*** (0.01)	0.039*** (0.016)	0.039*** (0.013)
FS	0.064*** (0.011)	0.065*** (0.011)	0.063*** (0.011)	0.065*** (0.015)	0.065*** (0.011)	0.063*** (0.011)	0.064*** (0.011)	0.063*** (0.011)
FII	0.0010 (0.0017)	0.0010 (0.0017)	0.0010 (0.0017)	0.0010 (0.0017)	0.0010 (0.0017)	0.0010 (0.0017)	0.0010 (0.0017)	0.0009 (0.0017)
DII	0.0015 (0.0012)	0.0013 (0.0012)	0.0013 (0.0012)	0.0013 (0.0012)	0.0013 (0.0012)	0.0014 (0.0012)	0.0013 (0.0012)	0.0014 (0.0012)
GROUP	-0.072 (0.103)	-0.054 (0.109)	-0.055 (0.103)	-0.067 (0.122)	-0.054 (0.102)	-0.070 (0.102)	-0.054 (0.19)	-0.070 (0.102)
Constant	0.731*** (0.21)	1.597*** (0.29)	1.427*** (0.31)	2.407*** (0.35)	1.619*** (0.29)	2.288*** (0.35)	1.804*** (0.32)	2.47*** (0.38)
Wald Chi-Square	170.93	197.57	195.66	206.36	191.17	215.4	193.07	217.64
Log-likelihood	-9500.38	-9490.61	-9487.96	-9483.07	-9490.33	-9478.6	-9457.9	-9477.57

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.5: Panel Tobit estimation using a sample of highly R&D intensive industries (PCOMP as measure of competition)

Variables	**Model 5.1**	**Model 5.2**	**Model 5.3**	**Model 5.4**	**Model 5.5**	**Model 5.6**	**Model 5.7**	**Model 5.8**
FAM	0.07*** (0.005)	0.09*** (0.008)	0.030** (0.016)	0.08*** (0.005)	0.072*** (0.0058)	0.033** (0.014)	-0.007 (0.0058)	0.034** (0.014)
FAMCEO	1.21* (0.717)	1.233* (0.72)	1.23* (0.72)	-0.85 (1.09)	1.24* (0.71)	-1.265 (1.103)	1.263* (0.716)	-1.02 (1.11)
DUAL	0.321* (0.169)	0.342** (0.168)	0.346** (0.168)	0.362** (0.168)	0.813 (0.555)	1.191** (0.563)	0.329** (0.168)	1.202** (0.563)
IND	0.33*** (0.023)	0.293*** (0.034)	0.312*** (0.033)	0.322*** (0.013)	0.269*** (0.021)	0.41 (0.044)	0.29*** (0.013)	0.31*** (0.039)
PCOMP		2.018*** (0.63)	1.068 (0.84)	0.90 (1.31)	1.47*** (0.26)	1.98 (1.42)	2.43 (2.38)	1.42** (0.57)
FAM*PCOMP			0.047* (0.025)			0.043* (0.025)		0.051** (0.025)
FAMCEO*PCOMP				1.77** (0.79)		1.55*** (0.31)		2.17*** (0.53)
DUAL*PCOMP					2.18** (1.005)	2.95*** (1.01)		2.94*** (1.019)
(PCOMP)^2							2.24** (1.18)	2.53* (1.25)
Size	1.270*** (0.262)	1.244*** (0.269)	1.271*** (0.264)	1.182*** (0.266)	1.261*** (0.265)	1.222*** (0.266)	1.198*** (0.264)	1.191*** (0.267)
Age	0.45*** (0.067)	0.38*** (0.067)	0.35*** (0.031)	0.28*** (0.022)	0.41*** (0.012)	0.21*** (0.023)	0.19*** (0.01)	0.16*** (0.01)
ROA	-0.972*** (0.071)	-0.59*** (0.072)	-0.59*** (0.072)	-0.56*** (0.071)	-0.66*** (0.073)	-0.62*** (0.072)	-0.61*** (0.072)	-0.61*** (0.071)
LEV	0.0875** (0.035)	0.0834** (0.034)	0.0860** (0.033)	0.0840** (0.033)	0.0860** (0.033)	0.0906** (0.032)	0.0834** (0.033)	0.091** (0.032)
EXP	0.091** (0.038)	0.085** (0.037)	0.084** (0.03)	0.086** (0.037)	0.084** (0.037)	0.081** (0.037)	0.093** (0.038)	0.087** (0.037)
FS	0.312*** (0.069)	0.317*** (0.069)	0.317*** (0.069)	0.318*** (0.061)	0.315*** (0.062)	0.313*** (0.068)	0.324*** (0.063)	0.318*** (0.069)
FII	0.0073 (0.0113)	0.0041 (0.0113)	0.0051 (0.0114)	0.0036 (0.0113)	0.0033 (0.0113)	0.0034 (0.0113)	0.0047 (0.0113)	0.0039 (0.0113)
DII	-0.004 (0.0075)	-0.004 (0.0075)	-0.004 (0.0075)	-0.002 (0.0075)	-0.003 (0.0075)	-0.003 (0.0075)	-0.004 (0.0075)	-0.003 (0.0075)
GROUP	0.771 (0.703)	0.717 (0.709)	0.757 (0.712)	0.686 (0.71)	0.715 (0.705)	0.723 (0.709)	0.724 (0.702)	0.733 (0.707)
Constant	-4.34*** (1.18)	-5.41*** (1.23)	-4.84*** (1.27)	-3.83*** (1.37)	-5.66*** (1.23)	-3.18** (1.41)	-4.33*** (1.34)	-2.42* (1.48)
Wald Chi-Square	221.96	233.86	237.06	241.2	239.13	253.68	238.23	256.7
Log-likelihood	-4540.66	-4535.62	-4534.2	-4532.43	-4533.23	-4526.87	-4533.74	-4525.59

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.6: Panel Tobit estimation using a sample of less R&D intensive industries (PCOMP as measure of competition)

Variables	Model 6.1	Model 6.2	Model 6.3	Model 6.4	Model 6.5	Model 6.6	Model 6.7	Model 6.8
FAM	-0.0003 (0.0013)	-0.00051 (0.0013)	0.0028 (0.0030)	-0.000021 (0.0013)	-0.000045 (0.0013)	0.0029 (0.0031)	-0.00011 (0.0013)	0.0025 (0.0031)
FAMCEO	-0.026 (0.086)	-0.047 (0.086)	-0.050 (0.085)	-0.048 (0.156)	-0.045 (0.086)	-0.127 (0.165)	-0.052 (0.086)	-0.161 (0.166)
DUAL	0.0098 (0.038)	0.0064 (0.038)	0.0065 (0.038)	0.0064 (0.034)	0.1244 (0.123)	0.1294 (0.126)	0.0064 (0.038)	0.128 (0.126)
IND	0.0102 (0.056)	-0.005 (0.058)	-0.007 (0.058)	-0.005 (0.058)	-0.006 (0.058)	-0.008 (0.056)	-0.006 (0.056)	-0.009 (0.056)
PCOMP		0.359*** (0.129)	0.467*** (0.153)	0.351* (0.211)	0.399*** (0.131)	0.415* (0.216)	1.347*** (0.468)	1.345*** (0.483)
FAM*PCOMP			-0.006 (0.0051)			-0.006 (0.0052)		-0.006 (0.0052)
FAMCEO*PCOMP				0.0025 (0.258)		0.149 (0.263)		0.206 (0.276)
DUAL*PCOMP					-0.216 (0.217)	-0.227 (0.228)		-0.227 (0.227)
(PCOMP)^2							-0.922*** (0.422)	-0.911** (0.425)
Size	-0.44*** (0.04)	-0.434*** (0.047)	-0.433*** (0.047)	-0.434*** (0.047)	-0.433*** (0.045)	-0.433*** (0.045)	-0.441*** (0.047)	-0.441*** (0.047)
Age	0.75*** (0.13)	0.713*** (0.133)	0.713*** (0.132)	0.713*** (0.133)	0.712*** (0.133)	0.710*** (0.133)	0.724*** (0.133)	0.720*** (0.133)
ROA	-0.373*** (0.11)	-0.320*** (0.114)	-0.318*** (0.115)	-0.320*** (0.114)	-0.31*** (0.114)	-0.320*** (0.114)	-0.317*** (0.114)	-0.319*** (0.114)
LEV	0.00005 (0.0002)	0.00005 (0.0002)	0.00007 (0.0002)	0.000076 (0.0002)	0.000068 (0.0002)	0.00001 (0.0002)	0.00005 (0.0002)	0.00004 (0.0002)
EXP	0.040*** (0.018)	0.039*** (0.010)	0.039*** (0.010)	0.039*** (0.010)	0.039*** (0.010)	0.039*** (0.010)	0.008*** (0.010)	0.008*** (0.010)
FS	0.064*** (0.011)	0.066*** (0.011)	0.065*** (0.015)	0.066*** (0.015)	0.066*** (0.011)	0.065*** (0.015)	0.066*** (0.011)	0.063*** (0.011)
FII	0.0010 (0.0017)	0.0009 (0.0017)	0.0008 (0.0017)	0.0009 (0.0017)	0.0009 (0.0017)	0.0008 (0.0017)	0.0008 (0.0017)	0.0007 (0.0017)
DII	0.0015 (0.0012)	0.0014 (0.0012)	0.0013 (0.0012)	0.0014 (0.0012)	0.0014 (0.0012)	0.0013 (0.0012)	0.0014 (0.0012)	0.0013 (0.0012)
GROUP	-0.072 (0.103)	-0.064 (0.104)	-0.063 (0.103)	-0.064 (0.103)	-0.064 (0.103)	-0.065 (0.104)	-0.065 (0.106)	-0.067 (0.106)
Constant	0.731*** (0.21)	0.589*** (0.224)	0.537** (0.227)	0.587** (0.242)	0.567** (0.225)	0.568** (0.243)	0.378 (0.245)	0.379 (0.258)
Wald Chi-Square	170.93	179.33	180.83	179.33	180.35	182.02	183.06	186.39
Log-likelihood	-9500.38	-9496.24	-9495.5	-9496.24	-9495.73	-9494.91	-9493.84	-9492.61

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.7: Panel Tobit estimation using a sample of group affiliated firms (DCOMP as measure of competition)

Variables	**Model 7.1**	**Model 7.2**	**Model 7.3**	**Model 7.4**	**Model 7.5**	**Model 7.6**	**Model 7.7**	**Model 7.8**
FAM	-0.0042*** (0.0016)	-0.0042*** (0.0016)	0.0097 (0.0083)	-0.0042*** (0.0016)	-0.004*** (0.0016)	0.011*** (0.0084)	-0.0043*** (0.0016)	0.011 (0.008)
FAMCEO	0.0178 (0.111)	0.0178 (0.111)	0.017 (0.111)	-0.485 (0.471)	0.0171 (0.111)	-0.609 (0.487)	0.019 (0.111)	-0.636 (0.481)
DUAL	-0.016 (0.046)	-0.016 (0.046)	-0.016 (0.046)	-0.016 (0.046)	-0.082 (0.269)	-0.013 (0.272)	-0.017 (0.046)	-0.026 (0.272)
IND	0.663*** (0.072)	0.663*** (0.072)	0.65*** (0.072)	0.66*** (0.0725)	0.663*** (0.072)	0.659*** (0.072)	0.662*** (0.072)	0.657*** (0.072)
DCOMP		-0.011 (0.333)	0.157 (0.347)	-0.375 (0.47)	-0.023 (0.337)	-0.277 (0.473)	0.947 (1.0004)	0.704 (1.036)
FAM*DCOMP			-0.016* (0.0094)			-0.017** (0.0095)		-0.017* (0.0095)
FAMCEO*DCOMP				0.572 (0.521)		0.713 (0.532)		0.745 (0.533)
DUAL*DCOMP					0.075 (0.305)	-0.0028 (0.308)		0.012 (0.309)
(DCOMP)^2							-0.97 (0.963)	-1.02 (0.966)
Size	0.061*** 0.025)	0.061** (0.025)	0.059** (0.025)	0.062*** (0.025)	0.061** (0.025)	0.0615** (0.025)	0.061** (0.025)	0.062** (0.025)
Age	0.147 (0.156)	0.147 (0.15)	0.147 (0.157)	0.151 (0.156)	0.147 (0.156)	0.152 (0.156)	0.144 (0.156)	0.148 (0.157)
ROA	-0.173* (0.089)	-0.173* (0.089)	-0.174** (0.089)	-0.169*** (0.091)	-0.173** (0.089)	-0.169* (0.090)	-0.172* (0.089)	-0.168* (0.09)
LEV	0.0003 (0.0006)	0.00034 (0.0006)	0.00033 (0.0006)	0.00034 (0.00069)	0.0003 (0.0006)	0.00034 (0.00069)	0.0003 (0.0006)	0.00033 (0.00069)
EXP	0.074*** (0.012)	0.074*** (0.012)	0.074*** (0.012)	0.074*** (0.011)	0.074*** (0.012)	0.073*** (0.012)	0.05*** (0.012)	0.074*** (0.012)
FS	-0.0043*** (0.00097)	-0.0043*** (0.0009)	-0.0043*** (0.0009)	-0.0043*** (0.00097)	-0.0043*** (0.0009)	-0.0043*** (0.00097)	-0.004*** (0.0009)	-0.004*** (0.00097)
FII	-0.0024 (0.0026)	-0.0024 (0.0026)	-0.0024 (0.0026)	-0.0023 (0.0026)	-0.0024 (0.0026)	-0.0023 (0.0026)	-0.0023 (0.002)	-0.002 (0.0026)
DII	-0.0012 (0.0013)	-0.0012 (0.0013)	-0.0012 (0.0013)	-0.0013 (0.0013)	-0.0012 (0.0013)	-0.0013 (0.0013)	-0.0013 (0.0013)	-0.0013 (0.0013)
Constant	-0.387 (0.311)	-0.37 (0.438)	-0.51 (0.445)	-0.066 (0.521)	-0.365 (0.441)	-0.139 (0.522)	-0.407 (0.439)	-0.15 (0.523)
Wald Chi Squ.	450.34	450.34	452.7	451.99	450.42	455.01	451.41	456.2
Log-likelihood	-12900.6	-12900.8	-12899.2	-12900	-12900.6	-12898.3	-12900.1	-12897.7

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.8: Panel Tobit estimation using a sample of standalone firms (DCOMP as measure of competition)

Variables	**Model 8.1**	**Model 8.2**	**Model 8.3**	**Model 8.4**	**Model 8.5**	**Model 8.6**	**Model 8.7**	**Model 8.8**
FAM	0.021***	0.0018	0.029***	0.0018	0.0018	0.021***	0.0018	0.021***
	(0.004)	(0.0014)	(0.0057)	(0.0014)	(0.0014)	(0.0057)	(0.0014)	(0.0057)
FAMCEO	0.137***	0.138	0.14**	1.36**	0.144***	1.586***	0.139	1.58**
	(0.032)	(0.012)	(0.05)	(0.671)	(0.02)	(0.671)	(0.152)	(0.67)
DUAL	-0.021	-0.0135	-0.099	-0.0155	0.444	0.461*	-0.0140	0.461*
	(0.055)	(0.055)	(0.055)	(0.055)	(0.293)	(0.294)	(0.055)	(0.29)
IND	0.909***	0.911***	0.922***	0.907***	0.913***	0.920***	0.912***	0.920***
	(0.087)	(0.0872)	(0.087)	(0.0871)	(0.087)	(0.087)	(0.087)	(0.087)
DCOMP		-3.223***	-2.68***	-4.493***	-3.156***	-4.062***	-3.59***	-4.135***
		(0.423)	(0.451)	(0.695)	(0.42)	(0.704)	(1.234)	(1.33)
FAM*DCOMP			0.023***			0.023***		0.023***
			(0.0067)			(0.0067)		(0.0067)
FAMCEO*DCOMP				1.707**		1.967***		1.96***
				(0.742)		(0.743)		(0.74)
DUAL*DCOMP					-0.532	0.549*		0.55*
					(0.335)	(0.335)		(0.335)
(DCOMP)^2							0.376	0.076
							(1.17)	(1.177)
Size	0.088***	0.1036***	0.1005***	0.10***	0.104***	0.0983***	0.103***	0.098***
	(0.0305)	(0.0304)	(0.0304)	(0.030)	(0.03)	(0.030)	(0.030)	(0.030)
Age	0.0536	0.0232	0.00004	0.047	0.0129	0.0159	0.0227	0.015
	(0.222)	(0.222)	(0.221)	(0.222)	(0.222)	(0.221)	(0.222)	(0.221)
ROA	-0.0336	-0.0254	-0.026	-0.025	-0.025	-0.027	-0.025	-0.0270
	(0.0429)	(0.042)	(0.0427)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
LEV	0.000089	0.00009	0.00009	0.0001	0.000099	0.0001	0.00009	0.0001
	(0.00033)	(0.00032)	(0.00032)	(0.0003)	(0.00032)	(0.0003)	(0.00032)	(0.0003)
EXP	0.00058	0.00063	0.00072	0.00064	0.00065	0.00077	0.0006	0.0007
	(0.0012)	(0.0012)	(0.00122)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0013)
FS	0.0023	0.0023	0.0022	0.002	0.0023	0.00195	0.0023	0.00195
	(0.0035)	(0.0035)	(0.0035)	(0.003)	(0.0035)	(0.0035)	(0.0035)	(0.0035)
FII	0.00031	0.00042	0.0001	0.00045	0.00040	0.0001	0.00041	0.00010
	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)
DII	-0.0035**	-0.0039**	-0.0040**	-0.0038**	-0.0038**	-0.0039**	-0.0039**	-0.0039**
	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.00184)
Constant	-0.454	2.613***	2.21***	3.69***	2.56***	3.39***	2.62***	3.39***
	(0.406)	(0.57)	(0.58)	(0.741)	(0.572)	(0.74)	(0.57)	(0.74)
Wald Chi Squ.	287.28	346.85	(359.58)	(352.32)	(349.67)	(369.31)	(346.96)	(369.31)
Log-likelihood	-13160.8	-13132.12	-13126.2	-13129.4	-13130.8	-13121.9	-13132.07	-13121.69

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.9: Panel Tobit estimation using a sample of group affiliated firms (PCOMP as measure of competition)

Variables	Model 9.1	Model 9.2	Model 9.3	Model 9.4	Model 9.5	Model 9.6	Model 9.7	Model 9.8
FAM	-0.0042*** (0.0016)	-0.0042*** (0.0016)	-0.0052** (0.0026)	-0.0042*** 0.0016)	-0.0043*** (0.0016)	-0.005** (0.0026)	-0.0042*** (0.0016)	-0.0052** (0.0026)
FAMCEO	0.0178 (0.111)	0.0166 (0.111)	0.016 (0.111)	0.0096 0.147)	0.015 (0.111)	-0.048 (0.151)	0.016 (0.11)	-0.045 (0.152)
DUAL	-0.016 (0.046)	-0.017 (0.047)	-0.017 (0.047)	-0.017 (0.047)	0.275** (0.131)	0.294** (0.133)	-0.016 (0.047)	0.301** (0.133)
IND	0.663*** (0.072)	0.663*** (0.0725)	0.664*** (0.075)	0.66*** (0.072)	0.657*** (0.072)	0.657*** (0.072)	0.664*** (0.072)	0.657*** (0.072)
PCOMP		0.0372 (0.110)	0.0080 (0.125)	0.028 (0.165)	0.125 (0.116)	0.022 (0.171)	-0.141 (0.4105)	-0.221 (0.422)
FAM*PCOMP			0.0021 (0.0043)			0.0021 (0.0043)		0.0021 (0.004)
FAMCEO*PCOMP				0.014 (0.195)		0.127 (0.203)		0.121 (0.203)
DUAL*PCOMP					-0.54*** (0.225)	-0.581*** (0.232)		-0.593*** (0.233)
(PCOMP)^2							0.178 (0.396)	0.252 (0.399)
Size	0.061*** 0.025)	0.0573** (0.028)	0.0584** (0.0282)	0.057** (0.0282)	0.051* (0.028)	0.052** (0.028)	0.066** (0.034)	0.064* (0.034)
Age	0.147 (0.156)	0.148 (0.156)	0.151 (0.156)	0.149 (0.157)	0.143 (0.156)	0.152 (0.1572)	0.1502 (0.156)	0.154 (0.157)
ROA	-0.173* (0.089)	-0.171** (0.090)	-0.172* (0.0901)	-0.171** (0.0901)	-0.166* (0.091)	-0.169** (0.0901)	-0.171** (0.091)	-0.168* (0.0901)
LEV	0.0003 (0.0006)	0.00033 (0.0006)	0.0003 (0.0006)	0.00034 (0.00069)	0.00034 (0.0006)	0.00035 (0.0006)	0.00034 (0.0006)	0.00035 (0.0006)
EXP	0.074*** (0.012)	0.0074*** (0.0012)	0.0074*** (0.0012)	0.0074*** (0.0012)	0.0074*** (0.0012)	0.0074*** (0.0012)	0.0074*** (0.0012)	0.0074*** (0.0012)
FS	-0.0043*** (0.00097)	-0.043*** (0.009)	-0.04*** (0.009)	-0.043*** (0.0098)	-0.043*** (0.009)	-0.043*** (0.0098)	-0.043*** (0.0098)	-0.043*** (0.0098)
FII	-0.0024 (0.0026)	-0.0024 (0.0026)	-0.0024 (0.0026)	-0.0024 (0.0026)	-0.0025 (0.0026)	-0.0026 (0.0026)	-0.0024 (0.0026)	-0.0025 (0.0026)
DII	-0.0012 (0.0013)	-0.0013 (0.0013)	-0.0012 (0.0013)	-0.0013 (0.0013)	-0.00143 (0.0013)	-0.0013 (0.0013)	-0.0012 (0.0013)	-0.0012 (0.0013)
Constant	-0.387 (0.311)	-0.395 (0.311)	-0.391 (0.311)	-0.39 (0.313)	-0.395 (0.311)	-0.367 (0.313)	-0.393 (0.311)	-0.366 (0.313)
Wald Chi Squ.	450.34	450.51	450.69	450.52	457.07	457.8	450.75	456.87
Log-likelihood	-12900.6	-12900.6	-12900.5	-12900.6	-12897.7	-12897.3	-12900.4	-12897.13

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

Table 5.10: Panel Tobit estimation using a sample of standalone firms (PCOMP as measure of competition)

Variables	**Model 10.1**	**Model 10.2**	**Model 10.3**	**Model 6.4**	**Model 6.5**	**Model 10.6**	**Model 10.7**	**Model 10.8**
FAM	0.021*** (0.004)	0.019*** (0.0014)	0.0017 (0.0027)	0.019*** (0.0014)	0.019*** (0.0014)	0.020*** (0.0027)	0.015*** (0.0014)	0.0009 (0.0027)
FAMCEO	0.137*** (0.032)	0.135** (0.062)	0.136*** (0.02)	-0.223 (0.202)	0.16*** (0.02)	-0.263 (0.2040)	0.14** (0.05)	-0.274 (0.203)
DUAL	-0.021 (0.055)	-0.024 (0.055)	-0.024 (0.0554)	-0.030 (0.0554)	0.157 (0.150)	0.2197 (0.1518)	-0.023 (0.055)	0.158 (0.151)
IND	0.909*** (0.087)	0.916*** (0.087)	0.916*** (0.0876)	0.925*** (0.087)	0.916*** (0.087)	0.927*** (0.087)	0.918*** (0.087)	0.93*** (0.087)
PCOMP		0.212* (0.114)	0.203 (0.143)	-0.322 (0.228)	0.257** (0.120)	-0.312 (0.236)	2.671*** (0.442)	2.084*** (0.48)
FAM*PCOMP			0.0004 (0.0045)			-0.0003 (0.0045)		0.0011 (0.005)
FAMCEO*PCOMP				1.69*** (0.255)		1.77*** (0.268)		1.75*** (0.261)
DUAL* PCOMP					-0.320 (0.2458)	-0.441* (0.249)		-0.331 (0.249)
(PCOMP)^2							-2.468*** (0.428)	-2.43*** (0.431)
Size	0.088*** (0.0305)	0.063** (0.0334)	0.063** (0.033)	0.049 (0.0337)	0.0599* (0.033)	0.042 (0.034)	-0.079** (0.041)	-0.094** (0.042)
Age	0.0536 (0.222)	0.0748 (0.2231)	0.0756 (0.223)	0.0849 (0.223)	0.071 (0.223)	0.0807 (0.223)	0.1023 (0.222)	0.111 (0.222)
ROA	-0.0336 (0.0429)	-0.032 (0.0429)	-0.032 (0.0429)	-0.029 (0.0429)	-0.032 (0.0429)	-0.029 (0.0429)	-0.033 (0.042)	-0.030 (0.042)
LEV	0.000089 (0.00033)	0.00003 (0.0003)	0.00008 (0.0003)	0.00006 (0.0003)	0.00001 (0.0003)	0.00001 (0.0003)	0.00002 (0.0003)	0.000054 (0.0003)
EXP	0.00058 (0.0012)	0.0003 (0.0012)	0.0003 (0.0012)	0.0002 (0.0012)	0.0003 (0.0012)	0.0001 (0.0012)	-0.0002 (0.0012)	-0.00067 (0.0012)
FS	0.0023 (0.0035)	0.0021 (0.0035)	0.0021 (0.0035)	0.0020 (0.0035)	0.0020 (0.0035)	0.0019 (0.0035)	0.0022 (0.0035)	0.0021 (0.0035)
FII	0.00031 (0.0023)	0.0002 (0.0023)	0.0002 (0.0023)	0.0005 (0.0023)	0.0002 (0.0023)	0.0004 (0.0023)	0.00008 (0.0023)	0.0003 (0.0023)
DII	-0.0035** (0.0018)	-0.003** (0.0018)	-0.003** (0.0018)	-0.003** (0.0018)	-0.003** (0.0018)	-0.003** (0.0018)	-0.004** (0.0018)	-0.004** (0.0018)
Constant	-0.454 (0.406)	-0.513 (0.408)	-0.513 (0.408)	-0.224 (0.422)	-0.522 (0.408)	-0.203 (0.421)	-0.596 (0.4077)	-0.287 (0.421)
Wald Chi Squ.	287.28	290.26	290.46	291.35	292.4	301.39	324.89	334.61
Log likelihood	-13160.8	-13159	-13159	-13161	-13158	-13153	-13142	-13137

Note: ***, **, and * denote significance level at 1 percent, 5 percent and 10 percent respectively. The values in parentheses are standard errors

In Table 5.9, when we replace the measure of domestic competition with the measure of price competition, the interaction term between family ownership and competition is insignificant. However, an interaction term between CEO-chairperson duality and price competition is found to be significantly negative suggesting that increasing competition adversely impact the relationship between family control and R&D intensity. Therefore, our findings from Table 5.7 and Table 5.10 support our hypothesis H10 indicating that the relationship between corporate governance and innovation is weaker among the group affiliated firms as the product market competition increases.

The results from the sample of standalone firms, however, are different from the results we find in the case of group-affiliated firms. As shown in Table 5.8, family ownership is a significantly positive variable in the case of standalone firms. The family-CEO is also found to be an important determinant, whereas little evidence is found in support of CEO-chairperson duality. The significance of the interaction terms suggests that domestic competition complements concentrated corporate governance to boost up R&D investments. After replacing the domestic competition variable with the measure of price competition (Table 5.10), we find that price competition does not interact significantly with family ownership. However, the interaction effect between price competition and family CEO is significant.

Overall, the findings provide greater support to the stewardship theory, agency theory and theory of SEW as discussed in section 2 earlier. Nonetheless, disaggregated analysis reveals that the findings can not be generalized to the entire manufacturing industry. As an important addition to the existing literature, we have found evidence supporting the complementary role of product market competition in influencing the relationship between family ownership/control and investments in innovation. However, the validity of the findings can be argued to be conditional upon the choice of the parameter used to calculate the level of market competition in our model.

To explain somewhat dissimilar results when two different measures of the product market competition are used, we have to consider how these are defined. DCOMP, as discussed earlier, defines competition in terms of the distribution of domestic market share. On the other hand, PCOMP is a measure of overall price competition that represents competition from foreign firms as well. It should be pointed out here that high competition in terms of firms' domestic market shares may not necessarily worsen the firms' financial situation (Cattó 1980; Anderson, Fornell, and Lehmann 1994), whereas intense price competition does it more explicitly (Porter 1980). Going by the argument, financial feasibility could be the reason for the family firms to be able to respond more positively to the increasing competition when it is domestic in nature. The price competition may not leave the firms with enough funds to invest in R&D even if the owners carry stewardship behaviour.

6. Concluding Remarks

The influence of corporate governance on R&D investment has been an emerging issue in family business research. This issue becomes more complex with the realization that family owners may behave differently in different structural contexts and in different organizational forms.

The literature on family businesses draws upon the principal-principal agency theory, stewardship perspective, behavioural agency model and family's socio-economic perspective to observe how strategic decisions and performance of the firms are influenced by the family's involvement. In this paper, the empirical exercise corroborates the findings of earlier studies on Indian industries (see Ashwin, Krishnan, and George 2015; Lodh, Nandy, and Chen 2014). The non-monetary objectives of the family firms to sustain their legacy over the long run encourage to invest more in R&D under increasing competition. As an important contribution to the literature in this stream, we find that the product market competition is an important moderating factor that may interact with corporate governance-related variables such as family ownership/control to influence innovative activities of the firms. Our findings show that product market competition and corporate governance are complementary in Indian manufacturing firms. In other words, family-owned firms become more innovative with an increase in market competition. This finding holds when we deconstruct family influence into three components viz. ownership, management and governance. Our findings suggest that Indian manufacturing firms are willing to spend on innovations to avoid the risk of bankruptcy and job loss through the disciplinary role of market capitalization (see Aghion, Dewatripont, and Rey 1999; Aghion, Carlin, and Schaffer 2002) The disaggregated analysis of group-affiliation and standalone firms indicates that the stewardship behaviour of the firms is significantly prominent in the case of standalone firms. The group-affiliated family firms, on the other hand, either suffer from agency costs or family involvement does not sufficiently impact the strategic decisions, such as R&D, of the firms. The interaction between family ownership/control indicators and product market competition is significant in standalone firms, whereas, the group-affiliated firms do not seem to be benefitting from this moderating effect between the two factors. This suggests that the predictions of the contracting theory hold good in the context of the relationship between corporate governance and innovation in the case of business group firms vis-a-vis standalone firms in the Indian manufacturing sector. In other words, as the majority shareholders have greater bargaining power over the minority shareholders in business group firms, it becomes difficult to raise funds for financing innovations in Indian manufacturing firms. On the other hand, the effect of the competition is relatively more pronounced in standalone firms due to the presence of 'satisficing' managers (Aghion, Carlin, and Schaffer 2002). It should be noted that the moderating effect of market competition is contingent upon the measure of product market competition. More specifically, it appears to be stronger when market competition is defined in terms of domestic market shares rather than as price-cost margin.

Considering that India has gradually rolled out market-friendly reforms starting from 1991, the product market competition has significantly increased. Our findings suggest, that firms with varying characteristics and corporate governance structures may have different approaches towards R&D investments while operating under different levels of competition levels. In this context, our findings may have important implications for a developing country like India that strives to encourage the participation of the private sector to boost up the R&D investments (STI Policy, Government of India 2013)[5]. We suggest that Science, Technology and Innovation (STI) policy should not be seen in isolation from corporate governance mechanism and competition policy as it has been done in the present policy.

The findings have some important implications in this context. With the increase in market competition, following economic reforms, proper incentives should be given to the manufacturing firms to implement properly the corporate governance principles as envisaged in clause 49 of the Listing Agreements to the Indian Stock Exchange (came into effect on December 31, 2005). Improved corporate governance along with increased competition would be beneficial in increasing R&D expenditure in manufacturing firms, which would, in turn, help these firms to increase productivity, exports and sustain the competition from foreign firms. Moreover, the policymakers should be concerned more with promoting standalone firms in Indian manufacturing sectors as the potential to innovate is more for this group of firms under increased market competition, compared to group affiliated firms.

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5. The draft of the recently proposed Science, Technology and Innovation policy (2020) also suggests that the country's technological goals will be achieved through support to the private sector.

Appendix (A)

Table A1: Descriptive statistics and correlation matrix

(Source: Authors' calculations using CMIE-Prowess data)

	Mean	Std. Dev.	Min	Max	RD	FAM	FAMCEO	DUAL	IND	DCOMP	PCOMP	Size	Age	ROA	LEV	EXP	FS	FII	DII	GROUP
RD	0.52	1.947	0	50.161	1															
FAM	18.46	21.38	0	99.37	0.042	1														
FAMCEO	0.701	0.457	0	1	0.047	0.26	1													
DUAL	0.211	0.408	0	1	0.056	0.14	0.33	1												
IND	0.252	0.278	0	1	0.19	-0.008	-0.024	0.17	1											
DCOMP	0.852	0.167	0.022	0.87	0.015	0.039	0.031	0.04	0.024	1										
PCOMP	0.507	0.224	0	0.91	0.0003	0.148	0.095	0.099	0.11	-0.013	1									
Size	2.948	1.099	-1.38	6.293	0.046	-0.053	-0.030	0.13	0.37	0.047	0.29	1								
Age	1.465	0.285	0	2.193	-0.021	-0.095	-0.12	0.06	0.21	0.029	0.04	0.30	1							
ROA	0.126	0.306	-5.24	27.35	0.0003	0.031	-0.021	0.002	0.042	0.022	0.006	0.092	0.015	1						
LEV	1.987	39.35	0	4383	-0.003	-0.006	-0.018	-0.006	-0.013	0.003	0.012	0.012	-0.006	-0.0081	1					
EXP	15.494	22.604	0	137.05	0.086	0.117	0.14	0.092	0.071	0.004	0.12	0.12	-0.11	0.022	-0.008	1				
FS	1.629	11.408	0	1224	0.006	-0.002	0.0075	-0.005	0.006	0.004	-0.005	-0.031	-0.017	-0.014	-0.003	-0.011	1			
FII	5.674	16.342	0	90	-0.005	-0.243	-0.25	-0.102	0.011	0.041	-0.044	0.14	0.12	0.032	0.025	-0.048	0.0032	1		
DII	22.396	22.824	0	94.07	-0.037	-0.442	-0.13	0.003	0.14	-0.02	0.083	0.26	0.17	-0.0005	-0.001	-0.047	0.0011	-0.22	1	
GROUP	0.514	0.499	0	1	-0.009	-0.24	-0.15	0.021	0.12	0.016	-0.036	0.26	0.21	-0.007	0.003	-0.075	-0.0052	-0.096	0.38	1

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