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Influence of Ownership Structure on the Innovation Activity of South Asian Companies at Different Life Cycle Stages

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Abstract

The lack of understanding management of corporate and financial innovation management in South Asia raises the fear of the declining effects of new technologies. Therefore, it is of practical interest to compare the estimates of the impact of ownership concentration in different innovation-intensive industries to minimize the agency problem among managers and shareholders. The paper provides an econometric analysis using panel regression of model testing on companies from technologically sophisticated industries, such as the Heavy and Light Industry, Information Technology (IT), and Consumer Staples from South Asia in different life cycles stages from 2015 to 2020. The South Asian market is volatile and receptive to innovations, but R&D capacity in some countries remains low. The paper provides a better understanding of the relationship between the concentration of different forms of ownership and the intensity of innovation, using industry specifics and life cycle stages. It's known that institutional investors are still interested in developing new digital marketing channels by competing with industry "disruptors" due to the lack of necessary strength in the IT industry along with barriers to cross-border investment. The paper confirms a linear and inverted U-shaped relationship between different forms of ownership structure and innovation activity. The results allow focusing on industrial and cultural differences to avoid agency and resource conflicts for majority shareholders of the company to build effective corporate governance, achieving strategic goals and minimizing the risks of improper management decisions in R&D.

Keywords: life cycles, R&D, insiders, institutional investors, innovative activity, South Asia

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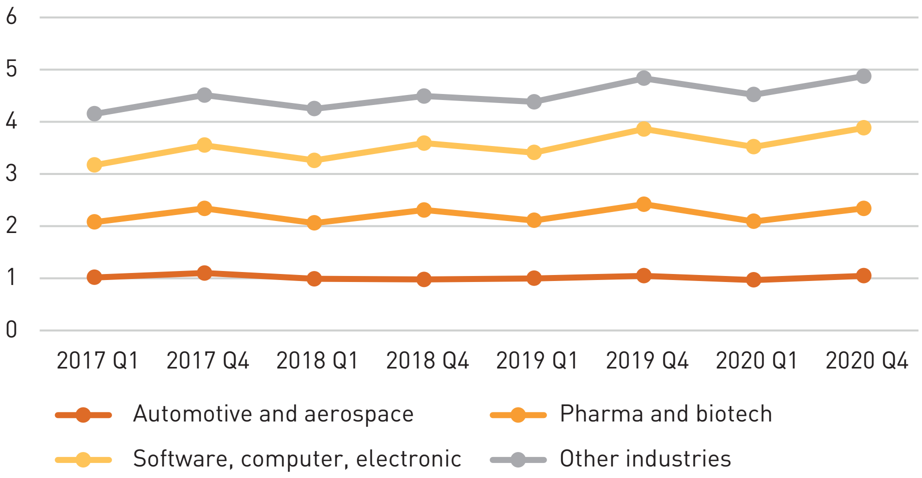
Introduction

Innovations are the head driver of both the growth intensity of developed and emerging economies and the market value of publicly traded companies. Companies focusing on developing new technologies have a higher market capitalization than traditional sector companies due to a higher potential for building competitive advantages in the future. However, global trends are also pushing companies in the traditional industries to compete with each other in piloting new products and changing management practices. For example, modern companies focus on developing the internal competencies of employees and transforming the organizational structure into a less hierarchical one to adapt faster to changes in the external environment. These conclusions were reached by [1] on data from American companies.

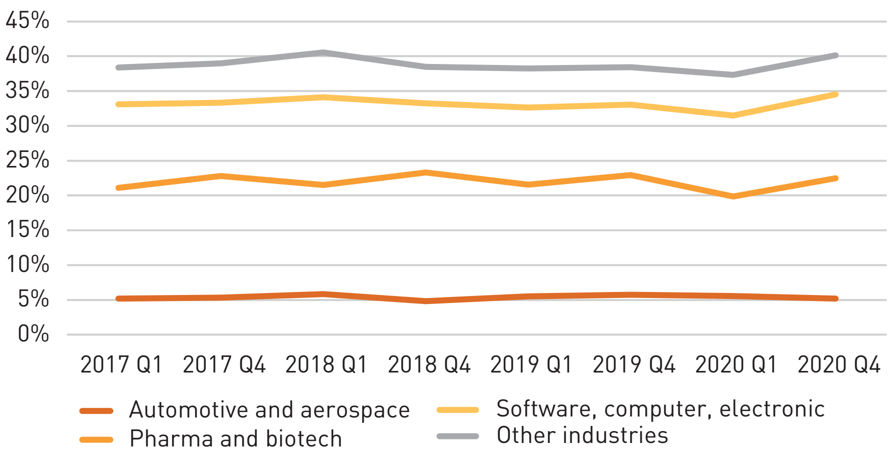
However, the intensity of innovation depends on the specifics of the industry and the level of technological development of a particular country. By section industry specifics, the main drivers of innovation regarding R&D investment are software, computers and their components (IT), pharmaceuticals and biotechnology, and automotive and aerospace. At the same time, other industries, including food processing and electrical engineering, have historically spent comparably less on R&D investments, as shown in Figure 1. On the other hand, for many technology industries, comparable levels of innovation intensity (R&D to revenue) have been sustained over the past four years and are less susceptible to business cycle fluctuations, as shown in Figure 2. For example, in the pharmaceutical and biotechnology sector, it is not possible to measure the effectiveness of a drug prior to clinical trials, so on average the relative R&D to revenue ratio for these industries is higher and reaches 16–18% over the historical period, which is less typical for the IT industry. Thus, the interest in studying the factors that influence the innovation rate is growing and persists to date.

Figure 1. R&D trend by industry group. Source: R&D trend in real terms extracted from OECD publications



Source: [2].

Figure 2. R&D intensity by industry group. Source: R&D intensity extracted from OECD publications



Source: [2].

The level of R&D investment varies across countries and companies at different life cycle stages which leads to higher productivity of R&D investment regardless of these differences, potentially producing misleading estimates and resulting conclusions, which may, in turn, cause sub-optimal R&D investment decisions at the firm's management level and have a generally negatively impact on their innovation and growth. Different levels of risk tolerance of shareholders and company management, motives and goals, and information asymmetry lead to the manager-shareholder agency problem. Agency theory suggests that increasing the share of internal and external owners is an effective mechanism for management to invest in R&D. However, the negative effect of insider ownership on innovation intensity may be greater that the positive effect of institutional ownership. Data from US multinational companies [3] demonstrates that insider ownership (insider ownership share) hurts innovation intensity. The presence of institutional investors strengthens the positive relationship between low managerial ownership and R&D expenditure but negatively affects the relationship between high managerial ownership and R&D expenditure.

R&D investment is calculated as a proxy indicator for different kinds of firm-level decisions [4], assuming that the activity of companies aimed at increasing productivity and building/maintaining competitive advantage favors such investments. However, the above statement can be rejected if the benefits outweigh the unfavorable outcomes of R&D investments because it does not guarantee positive effects. The future benefits of R&D investments are much more uncertain than other investments, such as capital expenditures [5; 6]. Although such investments may provide shareholders with higher returns, they negatively affect the firm's short-term financial performance and may only yield returns in the distant future. It is also necessary to consider the fact that the level of R&D investment varies across countries and firms at different stages of the life cycle [7]. An assumption of causality, i.e., R&D investment leading to higher productivity without accounting for these differences, which may yield misleading estimates and resulting conclusions. These uncertainties and the combination of the above factors may lead to suboptimal R&D investment decisions at the firm's management level and negatively affect their innovation and growth.

Different risk tolerance levels, and motives and goals of shareholders and company management, as well as information asymmetry lead to the manager and shareholder agency problem. The agency theory of the shareholder manager and the resource concept forms the theoretical justification for the presence of such a relationship. In particular, institutional investors and company management have conflicting interests because their time horizons differ [8]. The fiduciary responsibility of the former is to represent the long-term interests of their clients, and due to the high exit costs associated with significant investments, institutional investors develop long-term strategic relationships with the company. The concentration of ownership in the hands of certain types of shareholders affects the innovation activity of companies in different ways. In research, the impact of ownership concentration on innovation investment is mostly explained by agency theory, which states that there is a conflict of interest between owners and shareholders. Nevertheless, agency theory suggests that increasing the ratio of internal and external owners is an effective mechanism for management to make R&D investments. Due to this fact, there is still a debate in the literature regarding the form and direction of the influence of both insider and institutional ownership. For example, using the data from UK companies [9] showed that insider ownership has a non-linear relationship with innovation activity: small insider ownership has a positive relationship with innovation activity (logarithm of R&D expenditure), while greater insider ownership demonstrates a negative correlation, showing that companies in which the CEO or top management owns more shares produce fewer patents and focus on growth through mergers and acquisitions. A similar result on data from Chinese companies was found by [10], showing the negative impact of insider ownership and the positive impact of institutional ownership (ownership share of institutional investors) is translated with a 3-year lag. Also, S. Choi showed on data from companies in Korea that institutional ownership has a positive relationship with innovation activity.

The paper contributes to analyzing the impact of institutional and insider ownership concentration on investment in innovation activity of sector-specific South Asian companies at the growth and maturity stages. In the IT industry, innovations aim to improve the approbation of new technologies and finalize the existing ones. In the heavy and light industry sector, innovation activity is aimed to reduce costs of production technologies. There are marketing technologies and optimization of internal processes in the consumer staples industry. Investors favor more stable companies at the maturity stage, as their potential benefits increase with the investment horizon and the length of shareholding.

The expected results confirm that the most mobile resource for the formation of global financial capital for innovative development comprises the funds of institutional investors in free circulation in the economy, where the non-linear relationship between different forms of ownership structure and innovation activity can be resolved by the agent-based and resource-based theory, taking into account industry specifics and life cycle stages.

A more general question that this research aims to answer is whether the innovative activity of companies increases as a result of structuring the motives for managing ownership concentration, with regard to technological specifics. More specifically, the questions posed by this research are as follows:

1) How can different types of ownership concentration affect innovative activity by industry?
2) What are the main motives behind the influence of ownership concentration on innovation activity at the growth and maturity stages of the life cycle?

This research fills a scientific gap in the study of the impact of institutional and insider ownership concentration on investments in innovation activity of companies in South Asia from different industries in terms of technological complexity at the growth and maturity stages.

Related literature

The literature on the topic can be split into two main types. The first is devoted to the relationship between innovation activity, ownership structure, and financial company metrics. The present section of the research will help to determine the basic methodology.

The second section is a description of innovation activity and ways to measure it, along with a definition of the stages of a company's life cycle that will allow us to define the variables for the study.

Influence of ownership structure on innovative development and financial results of the company

Innovation activity is divided into two groups of indicators – Innovation input and Innovation output, where in case of the former the intensity of innovations shows how much the company is interested in innovation. Innovation input includes the group of indicators comprising the ratio of R&D to revenue, R&D to assets, and the ratio of NMA to assets. Innovation outputs can be measured, for example, by the number of patents and citation of patents.

Implementing innovation provides value for the company, and financial performance can be improved, so it is necessary to identify the determinants that influence innovation.

Innovation activity has a positive effect on the future growth of the company. Innovation activity, calculated as the ratio of R&D to assets with a lag of one year, is positively related to revenue growth in Korean pharmaceutical companies [11]. In addition to research, it has been demonstrated that an increase in R&D expenditure has a positive relationship with revenue growth and number of employees.

Also, innovation activity can be a signal for investors. Innovation intensity has a positive relationship with the company's market capitalization, return on assets, and return on equity. The positive relationship between innovation intensity was also shown by [12] on data from Chinese companies and by [13] on data from European companies. The concentration of ownership in the hands of certain types of shareholders affects firms' innovation activity in different ways. In previous studies, the effect of ownership concentration on innovation investment is related to agency theory, which states that there is a conflict of interest between owners and shareholders. H. Ahmed showed a non-linear relationship between innovation activity and insider ownership [9]. S. Choi demonstrated that institutional and foreign ownership has a positive relationship with innovation activity, while most of property ownership is retained by family shareholders, which leads to lower innovation intensity. The authors also concluded that private equity (private funds) can offset the risk aversion of family owners and stimulate R&D spending in firms. Analyzing data from public Spanish companies, [14] determined that concentration of family ownership has an inverse U-dependence: small family ownership increases firm innovation activity, while extended family ownership decreases it. As shown, institutional ownership positively affects a firm's innovation activity.

Studying the impact of corporate governance of US industrial companies that generate most of their revenues internationally on innovation intensity, used the percentage of shares owned by institutional investors and the percentage of voting shares owned by insiders to test the impact of institutional and insider ownership on innovation activity, which measured as the ratio of R&D to revenues [3]. For regression, the generalized least squares (GLS) method. The research results allow the authors to conclude that institutional ownership is insignificant and insider ownership hurts innovation intensity.

S. Choi also used the percentage of ownership by insiders and institutional investors to investigate the effect of ownership on the innovation activity of Chinese firms, which they calculated as the number of registered patents. Because of a problem of excessive variance in patent data in the authors' final sample, the authors concluded that there were necessary dynamics and unobserved cross-sectional heterogeneity in the analysis. It used negative binomial regression to account for such characteristics in the data. The results revealed that insider ownership negatively affects innovation activity with a lag of 3 years and institutional ownership positively with a lag of 3 years.

[16] used the percentage of insider and institutional (divided into bank and corporate ownership) ownership and squared these variables to estimate the effect of ownership on innovation intensity. The multilevel linear model was used to conduct this study.

According to the modeling results insider ownership was found to be insignificant, whereas corporate and banking ownership have a positive relationship on innovation intensity and have a U-shaped relationship.

H. Ahmed investigated the relation of corporate managers with the innovation activity of firms in the United Kingdom, calculated as the logarithm of R&D expenditures, using panel regression with fixed effects.

This variable in the square of the percentage of manager ownership was a proxy for insider ownership. It also used the variable in the square of the percentage by institutional investors. To test the authors' hypothesis that institutional investors have a moderating effect on managers (it was supposed that the percentage of managerial ownership hurts R&D expenditures), an iterative variable, the multiplication of the percentage of institutional investors by the percentage of managers and this variable squared, was introduced.

Results of the model revealed that managers' ownership share positively affects R&D, managers' squared ownership share negatively affects R&D, institutional ownership share positively affects R&D, and the iterative variable of institutional and managerial ownership positively affects R&D. The authors conclude that the presence of institutional investors strengthens the positive relationship between low managerial ownership and R&D expenditure, but does not affect the negative relationship between high managerial ownership and R&D expenditure.

Assessment of the innovation activity of the company through the life cycle

To measure innovation production, the number of patent citations and the average number of citations per patent were used. These indicators allow us to study the effectiveness of innovation activity, which shows how much other scientists and researchers are interested in the company's scientific development. The same method was used by [17].

One of the main drivers of a company's competitiveness is investment in innovation. R&D results are the main driving force that affects financial performance and firm value. The benefits of R&D accumulate over the long term and have relatively uncertain benefits compared to capital expenditures, so managers need to understand how and when to maximize R&D benefits with limited resources.

Businesses at different stages of the LCR understand their advantages to maximize the benefits of innovation. For example, growing companies will spend more on capital expenditures to improve their competitive advantage, which positively affects the stock returns of such companies. The LCR includes growth, maturity, and stagnation stages. Firms in the growth stage focus on increasing revenues and assets to gain a competitive advantage. In the maturity stage, firms have steady sales growth, reduced R&D, and bureaucratic organizational structure. In the stagnation stage, firms are specialized by insufficient R&D expenditure and declining revenues. A company's R&D expenditure may vary depending on the stage of its life cycle. In the growth stage, firms focus on customer relationship management and new product development and therefore, invest a lot of cash in R&D. In the maturity stage, firms are most competitive. As firms pass through the maturity stage, they require more investment in R&D to accelerate innovation. When firms enter the stagnation stage, stable resource utilization weakens their innovation. At this stage, firms are no longer competitive and profitable, and they do not have sufficient resources for R&D.

[18] showed that revenue and capital expenditure growth is a function of the stages of the LCR. The authors categorized companies into groups based on the characteristics of the LCR and investigated the stock market reaction to changes in various financial indicators. Financial indicators, such as company age, dividend payout ratio, revenue growth, and capital expenditure to firm value ratio were used to categorize companies by stages of the LCR. This paper is divided into three sections according to stages of the LCR: growth, maturity, and stagnation. The unidimensional and multidimensional ranking were applied to determine the stage of the life cycle. For example, companies in the growth stage had low dividend payouts, high revenue growth, and capital expenditures and were young.

This method of determining the stage of the LCR was used by [19] when they investigated the effect of R&D contingencies on the companies' stock returns. The authors concluded that market reactions to increased R&D expenditures are the most negative in the maturity stage. The relationship between R&D and stock returns is non-linear and is influenced by the LCR.

It is worth noting that when Anthony J. and Ramesh K conducted their study of LCR, cash flow disclosure was not yet mandatory for US companies. In the work [20] cash flows (operating, investing, and financing) were used to determine the stages of LCR. This approach has advantages: firstly, it reflects all of the company's financial information rather than one group of indicators (such as company age and sales growth), secondly, it is periodic, indicating the true state of the business life cycle. Overall, Dickinson noted five main cycles of companies: introduction, growth, maturity, shake-out, and decline. Stages of the life cycle were determined based on the combination of signs (+/–) of the three cash flows.

Theory and hypotheses

Relationship between institutional ownership concentration and innovation intensity

A high concentration of institutional ownership has a positive *relationship with* **innovation intensity. In other words, if the coefficient estimates o**f the institutional ownership concentration variable are significant and with a positive sign, the null hypothesis is not rejected. Thus, the company's acquisition of deep knowledge of local markets, obtained as a result of the relationship with an institutional investor, levels out information asymmetry and helps to successfully invest in R&D and use competitive advantages at the international level.

H1: *A high degree of ownership concentration* on *institutional investors has a positive relationship with the intensity of innovation* structure [3].

Nevertheless, some empirical papers have found an inverse U-shaped relationship between different forms of institutional ownership structure, including financial, except banks, insurance institutions, and corporate investors. The theoretical justification is that up to a certain level institutional owners receive direct and indirect benefits from R&D investments: 1) profits from control and monitoring of managers introducing know-how products to the market; 2) equalization of bargaining power when institutional investors invest in another company; 3) risk sharing among the remaining shareholders, which exceeds the risk of the latter and the long-term payback horizon, but as ownership grows, risks become less diversified among shareholders, as a consequence, preferences for risky R&D investments decrease, moving to the phase of a conservative investment program with a high payback guarantee. Low and moderate concentrations of institutional ownership will have a positive relationship with the intensity of innovation, but beyond a certain level, there will be a negative dependence [21].

H1.1: The high degree of ownership concentration among institutional investors has an inverse U-shaped dependence [16].

The relationship between insider ownership concentration and innovation intensity

According to agency theory, one way to monitor a manager's opportunistic behavior is to increase board members' ownership of the firm [22]. However, executives who are company managers (insiders) cannot monitor impartially because of the risk to their self-interest (for example, maintaining their current positions). Thus, it is assumed that the self-interest of insiders in short-term financial performance outweighs long-term, high-risk R&D investments. The concentration of ownership in the hands of insiders is assumed to hurt the intensity of innovation. In other words, if the coefficient of estimation of the insider ownership concentration variable is significant and with a negative sign, the null hypothesis is not rejected.

***H2:** The high degree of concentration of ownership in the hands of insiders negatively affects the intensity of innovation* [3].

A low or moderate concentration of insider ownership has a positive relationship with R&D investment, but an inverse relationship occurs after a certain level. On the one hand, a restrained share of insider ownership can align the interests of shareholders and managers, reducing the opportunistic behavior of the latter as a result, stimulating investments with long-term and uncertain outcomes, such as R&D. However, it can be supposed that as the ownership of the company increases, the incentives for such innovations, including the emergence of incentives for self-interested motives, the reduction of unnecessarily risky investments, as a consequence of losses to their financial position, decrease due to the high rigidity of the manager. Thus, it suspects that there is an inverse U-shaped dependence between insider ownership and subsequent R&D investments.

***H2.1:** A high degree of ownership concentration in the hands of insiders has an inverse U-shaped relationship* [16].

The relationship between ownership concentration and innovation intensity, and firm size

Company size plays an important role in assessing the impact of the concentration of different forms of ownership. Large companies have more prerequisites to be innovative compared to smaller companies. The theory suggests that R&D activities (called "creative destruction") is characterized by economies of scale: 1) R&D investment is a fixed cost and does not depend on the scale of production, which is confirmed by the ratio of gross domestic expenditure to R&D; 2) the risks of R&D investment can be better absorbed by large companies than by small companies; 3) large companies are more likely to benefit from the returns on R&D investment [23]. Thus, the effect of ownership concentration on innovation intensity is presumed to be more distinct in large companies. In other words, if the slope coefficient estimation for a variable is significant and greater than the coefficient estimation in hypotheses H1 or H2, the null hypothesis is not rejected.

***H3:** Ownership concentration has a more* distinct *effect on innovation intensity in large companies.*

The effect of ownership concentration on innovation intensity as related to life cycle stages

The paper pays much attention to analyzing the impact of ownership concentration on innovation intensity at different life cycle stages. The researchers point out that during the growth stage, unstable consumer preferences and growing demand continue to stimulate the growth of product innovation intensity. During the transition to the maturity stage, products become more standardized, and companies compete in performance or efficiency. Innovation in product solutions is replaced by innovation in firm processes, focusing on managerial best practices. Nevertheless, there is no convincing empirical work that confirms that innovation activity is less in the maturity stage than in the growth stage.

The relationship between different forms of ownership and innovation as a company moves through life cycle stages is poorly understood [24] despite extensive research on the impact of corporate governance components on innovation activity [25–28]. In particular, Cucculelli M. and Peruzzi V. test multidirectional hypotheses about the impact of institutional ownership on innovation activity at the maturity stage: 1) at the maturity stage, institutional owners have a short planning horizon and expect a return on their investment through short-term financial results [29]. Thus, the probability of investing in R&D is lower than in the growth stage; 2) since financially controlled firms have better performance and management practices than other firms [30], they may be more able to identify growth opportunities arising from investment in innovation, even during maturity. Thus, a hypothesis has been formulated based on the second assumption.

***H4:** The impact of institutional ownership concentration increases from the growth stage to the maturity stage.*

The effect of ownership concentration on innovation intensity concerning the industry specifics

Of particular interest is the comparison of estimates of the impact of ownership concentration in different innovation-intensive industries. Previous works implicitly estimated the impact of insider (in the person of the company's management) ownership depending on the innovation intensity of an individual company rather than the industry as a whole. Managerial ownership positively affects R&D expenditure in firms with low R&D intensity [9], but negatively in German firms with high R&D intensity. In this paper, it is supposed that a high concentration of some ownership in industries with high innovation intensity, such as the IT industry, has a distinct impact since R&D investments in this case are the prerogative of their further development. Thus, the level of innovation intensity in high-tech industries is established using the determinants of corporate governance, namely the level of institutional and insider ownership concentration, the characteristics of top management, and the composition of the board of directors. Thus, the hypothesis tested the proposition that the effect of ownership concentration is distinct and more significant in industries with high innovation intensity compared to industries with low intensity.

***H5:** Ownership concentration has a much more distinct influence in industries with high innovation intensity.*

Data and Methods

Data

Providing an assessment of the effect of innovation intensity on the capital structure of Southeast Asian companies, the paper examines the relationship of corporate governance with companies that generate most of their revenue in the international market using the percentage of shares held by institutional investors as well as the percentage of voting shares held by insiders [3]. The main criterion for collecting data from the largest developed economies is the fact that these regions have a high concentration of large technology companies that invest heavily in R&D. The high heterogeneity of companies by sector and stage of the life cycle allows us to analyze the impact of variables on the total sample at different levels of detail in Table 1: 1) high-tech companies (high and medium-high technology firms) at the stage of growth and maturity; 2) low-tech companies (medium, medium-low, and low technology firms) at the stage of growth and maturity.

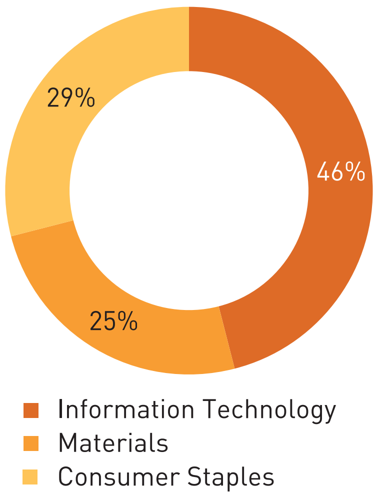
Table 1. OECD taxonomy of economic activities based on R&D intensity

	Manufacturing	R&D as % of GVA[2]	Non-manufacturing	R&D as % of GVA[2]
High R&D intensity industries	303[1]: Air and spacecraft and related machinery	31.69	72: Scientific research and development	30.39
	21: Pharmaceuticals	27.98	582[1]: Software publishing	28.94
	26: Computer, electronic and optical products	24.05		
Medium-high R&D intensity industries	252[1]: Weapons and ammunition	18.87	62-63: IT and other information services	5.92
	29: Motor vehicles, trailers and semi-trailers	15.36		
	325[1]: Medical and dental instruments	9.29		
	28: Machinery and equipment n.e.c.	7.89		
	20: Chemicals and chemical products	6.52		
	27: Electrical equipment	6.22		
	30X[1]: Railroad, military vehicles and transport n.e.c. (ISIC 302, 304 and 309)	5.72		
Medium R&D intensity industries	22: Rubber and plastic products	3.58		
	301[1]: Building of ships and boats	2.99		
	32X[1]: Other manufacturing except medical and dental instruments (ISIC 32 less 325)	2.85		
	23: Other non-metallic mineral products	2.24		
	24: Basic metals	2.07		
	33: Repair and installation of machinery and equipment	1.93		
Medium-low R&D intensity industries	13: Textiles	1.73	69-75X: Professional, scientific and technical activities except scientific R&D (ISIC 69 to 75 less 72)	1.76
	15: Leather and related products	1.65	61: Telecommunications	1.45
	17: Paper and paper products	1.58	05-09: Mining and quarrying	0.80
	10-12: Food products, beverages and tobacco	1.44	581[1]: Publishing of books and periodicals	0.57
	14: Wearing apparel	1.40		
	25X[1]: Fabricated metal products except weapons and ammunition (ISIC 25 less 252)	1.19		
	19: Coke and refined petroleum products	1.17		
	31: Furniture	1.17		
	16: Wood and products of wood and cork	0.70		
	18: Printing and reproduction of recorded media	0.67		
Low R&D intensity industries			64-66: Financial and insurance activities	0.38
			35-39: Electricity, gas and water supply, waste management and remediation	0.35
			59-60: Audiovisual and broadcasting activities	0.32
			45-47: Wholesale and retail trade	0.28
			01-03: Agriculture, forestry and fishing	0.27
			41-43: Construction	0.21
			77-82: Administrative and support service activities	0.18
			90-99: Arts, entertainment, repair of household goods and other services	0.11
			49-53: Transportation and storage	0.08
			55-56: Accommodation and food service activities	0.02
			68: Real estate activities	0.01

Source: [31].

The data was obtained from the following information sources: Bloomberg, Thomson Reuters, and Capital IQ. Data includes information on the company balance sheet structure (total assets and total debt), revenues and expenses (revenue, EBITDA, and net income), cash flows (total operating, investing, and financing flows, R&D investments), shareholder structure (shares of institutional investors and insiders) and general information (GICS industry affiliation in Figure 3) from 2015 to 2020. To improve the accuracy of the analysis, companies with significant omissions, some of which were delisted from the stock exchange during the study period or lost their public company status and were involved in a merger transaction during the study period, were excluded from the dataset. Statistical data includes 3242 companies (over six years) that invested in R&D over the entire study period from 2015 to 2020.

Figure 3. Distribution of companies by industry. Source: Author's own calculations and elaborations



The disaggregation of the sample at the level of each industry reduces right-sided asymmetry and heterogeneity; however, it is also present within each industry group, but to a lesser extent.

The data includes information about the companies' balance sheet structure (total assets and total debt), revenues and expenses (revenue, EBITDA, and net income), cash flows (total operating, investment, and financing flows, R&D investments), shareholder structure (shares of institutional investors and insiders). Proxy variables, such as the percentage of stock ownership by institutional investors (INST) and the percentage of stock ownership by insiders (INSD) of ownership structure, were used for the analysis. The research used panel regression characterized by Generalized Least Squares (GLS) method with random effects and cluster errors. The analysis and estimation were conducted using two models, one analyzed using linear regression and the other – using negative binomial regression. The random effects model assumes that the unobserved characteristics of the companies in the sample vary randomly. Moreover, this model allows for the inclusion of time-invariant variables, unlike the fixed effects model, which excludes them through the differentiation process. It is reasonable to expect that the differences between companies do affect innovation activity, so the random effect model should be more robust. Three indicators were used as control variables, one of which is company size (SIZE), calculated through the logarithm of assets and characterizing economies of scale, as well as accumulated resources for greater involvement in innovation activity. Leverage (LVG) affects the innovation activity of companies by regulating R&D expenditures and controlling financial constraints that may reduce the intensity of innovation. Profitability (EBTD_MRGN) is also used as a control variable and calculated as the net income ratio to assets. Profitability is assumed to have a positive relationship with innovation activity because more profitable companies have more funds to spend on innovation activities [32].

Measures

Descriptive statistics of the total sample of unbalanced panel data are presented in Table 2. The data have high heterogeneity in financial and non-financial indicators. In particular, the average values of innovation intensity (R&D_NS), ownership concentration, and financial indicators are significantly higher than the median values, which means a right-sided distribution asymmetry. Another level of sample detail implies the division of companies by life cycle stages. In particular, at the maturity stage, companies demonstrate a higher level of innovation intensity than at the growth stage, which is consistent with the methodology. In addition, the average size of such companies (T_ASSETS) is on average larger and the level of ownership concentration is also higher than at the earlier stage.

Table 2. Descriptive statistics at different stages of the life cycle for the total sample

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	5 171	5 171	4 184	5 171	5 171	5 171	5 171
	Mean	3.8	30.0	8.4	1.1	12.2	2 232	6.0
	SD	6.1	23.9	12.4	5.3	9.5	11 789	1.7
	p25	0.7	10.7	0.5	0.0	6.3	130	4.9
	p50	1.8	24.7	3.0	0.1	9.8	335	5.8
	p75	4.4	44.1	10.8	0.5	14.8	1 129	7.0

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Maturity	N	5 418	5 418	4 315	5 418	5 418	5 418	5 418
	Mean	5.0	35.0	9.6	1.4	13.8	5 691	6.4
	SD	6.5	29.3	13.5	5.3	10.3	19 856	2.1
	p25	0.8	9.5	0.4	0.0	6.7	121	4.8
	p50	2.5	26.3	3.5	0.3	11.8	389	6.0
	p75	6.7	56.3	14.0	1.0	18.0	2 450	7.8
Total	N	10 589	10 589	8 499	10 589	10 589	10 589	10 589
	Mean	4.4	32.6	9.0	1.3	13.0	4 002	6.2
	SD	6.3	26.9	13.0	5.3	9.9	16 509	1.9
	p25	0.7	10.2	0.5	0.0	6.5	125	4.8
	p50	2.1	25.4	3.2	0.1	10.6	357	5.9
	p75	5.2	49.8	12.5	0.8	16.5	1 569	7.4

Source: Author's own calculations and elaborations.

A comparative analysis of industries in Tables 3–5 indicates that the average innovation intensity is higher in IT than in heavy and light industries and the consumer sector, which is also in line with the OECD classification. In terms of ownership structure, the average share of institutional investors is higher in the consumer and industrial sectors, which is not the case for the IT industry. However, it is assumed that the relationship between ownership concentration and innovation intensity is positive.

Table 3. Descriptive statistics at different stages of the life cycle for Consumer Staples industry

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	845	845	668	845	845	845	845
	Mean	1.4	29.8	10.0	0.9	10.4	2 303	6.2
	SD	3.4	22.4	15.1	2.9	7.9	9 448	1.6
	p25	0.4	12.4	0.4	0.0	5.5	165	5.1
	p50	0.8	25.6	1.9	0.1	8.1	487	6.2
	p75	1.4	41.3	14.1	0.4	13.0	1 659	7.4
Maturity	N	873	873	683	873	873	873	873
	Mean	1.5	42.9	6.7	1.7	14.1	11 263	7.3
	SD	2.3	28.8	12.1	6.6	9.9	28 750	2.2
	p25	0.4	17.3	0.2	0.1	6.7	237	5.5
	p50	0.9	37.9	0.8	0.5	12.5	1 286	7.2
	p75	1.7	69.9	5.9	1.4	18.8	7 918	9.0
Total	N	1 718	1 718	1 351	1 718	1 718	1 718	1 718
	Mean	1.4	36.4	8.3	1.3	12.3	6 856	6.8
	SD	2.9	26.6	13.8	5.1	9.1	21 994	2.0
	p25	0.4	14.8	0.3	0.0	5.9	197	5.3
	p50	0.8	30.0	1.5	0.2	9.8	759	6.6
	p75	1.5	55.1	10.2	1.0	16.8	3 362	8.1

Source: Author's own calculations and elaborations.

On the other hand, the IT industry is characterized by a higher proportion of insiders in the ownership structure, which is also consistent with the theory that low to moderate concentration of insider ownership has a positive relationship with R&D investment. The comparative characterization of firms in different industries at different life cycle stages allows us to track innovation intensities (R&D_NS) and changes in ownership structure during the transition from growth to maturity stage. In the consumer sector, firms tend to maintain a stable level of innovation intensity when moving to the late stage, however, the concentration of institutional investors increased on average across the sample, while the share of insiders decreased on the contrary. Financial indicators (LVG, EBT_MRGN, T_ASSETS) of mature companies grew on average, which is also consistent with the life cycle theory, companies on average become larger with sustainable competitive advantages, which allows for high EBITDA margins for shareholders. At the IT maturity stage, companies in the 75% percentile tend to increase their innovation intensity, for these companies the concentration of institutional shareholders and insiders is higher on average. In the remaining cases, the level of innovation intensity does not change significantly when moving to the maturity stage.

Table 4. Descriptive statistics at different stages of the life cycle for Information Technology industry

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	2 620	2 620	2 139	2 620	2 620	2 620	2 620
	Mean	6.0	27.7	9.8	1.7	12.8	1 848	5.5
	SD	7.6	24.6	12.2	6.9	10.5	14 322	1.6
	p25	1.5	8.2	1.1	0.0	6.2	91	4.5
	p50	3.7	20.0	5.0	0.1	10.2	213	5.4
	p75	7.5	40.7	13.9	0.8	16.0	602	6.4
Maturity	N	3 273	3 273	2 660	3 273	3 273	3 273	3 273
	Mean	7.0	30.9	10.5	1.7	13.6	3 930	5.8
	SD	7.4	28.6	13.3	5.6	10.9	18 418	1.9
	p25	1.9	7.3	1.2	0.0	6.1	96	4.6
	p50	4.5	21.1	5.1	0.3	11.0	223	5.4
	p75	9.7	47.7	15.4	1.2	17.9	931	6.8
Total	N	5 893	5 893	4 799	5 893	5 893	5 893	5 893
	Mean	6.6	29.5	10.2	1.7	13.3	3 004	5.7
	SD	7.5	26.9	12.8	6.2	10.7	16 752	1.8
	p25	1.7	7.7	1.2	0.0	6.2	93	4.5
	p50	4.1	20.6	5.1	0.2	10.6	217	5.4
	p75	8.6	44.6	14.9	1.0	16.9	758	6.6

Source: Author's own calculations and elaborations.

Companies from the industrial sector are characterized by an increase in institutional and insider ownership as they move to a later stage, but the level of innovation intensity does not change significantly between stages. Thus, the consumer and industrial sectors have a higher concentration of institutional investors at the maturity stage with relatively stable levels of innovation intensity. However, the share of insiders is higher only in the industrial sector. In the IT sector, companies with a high concentration of institutional and insider ownership have a higher intensity of innovation when moving to the maturity stage, while the level of ownership is much lower than in other industries.

Table 5. Descriptive statistics at different stages of the life cycle for Materials industry

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	1 706	1 706	1 377	1 706	1 706	1 706	1 706
	Mean	1.8	33.8	5.4	0.4	12.0	2 786	6.6
	SD	2.4	23.2	10.6	2.3	8.5	7 849	1.5
	p25	0.5	15.3	0.2	0.0	6.9	226	5.4
	p50	1.2	29.8	0.9	0.1	10.0	592	6.4
	p75	2.5	48.4	4.6	0.2	14.2	1 911	7.6
Maturity	N	1 272	1 272	972	1 272	1 272	1 272	1 272
	Mean	2.1	40.1	9.0	0.6	14.0	6 400	7.1
	SD	2.7	29.6	14.6	2.6	8.9	14 497	2.0
	p25	0.5	13.1	0.2	0.0	8.4	267	5.6
	p50	1.2	36.3	1.0	0.1	12.9	1 097	7.0
	p75	2.8	62.8	12.9	0.6	17.5	5 666	8.6
Total	N	2 978	2 978	2 349	2 978	2 978	2 978	2 978
	Mean	1.9	36.5	6.9	0.5	12.9	4 329	6.8
	SD	2.5	26.3	12.5	2.4	8.7	11 323	1.8
	p25	0.5	14.4	0.2	0.0	7.4	246	5.5
	p50	1.2	31.4	0.9	0.1	11.1	725	6.6
	p75	2.6	54.4	6.6	0.3	15.8	3 029	8.0

Source: Author's own calculations and elaborations.

Table 6 presents the correlation matrix of the variables used in the regression analysis.

Table 6. Correlation matrix

	R&D_NS	INST	InsD	LVG	EBTD_MRGN	SIZE
R&D_NS	1.00					
INST	0.11	1.00				
InsD	0.05	–0.35	1.00			
LVG	0.13	0.09	0.01	1.00		
EBTD_MRGN	0.15	0.21	0.02	0.04	1.00	
SIZE	–0.13	0.54	–0.31	–0.02	0.22	1.00

Source: Author's own calculations and elaborations.

There is no significant correlation between the variables (correlation does not exceed 60%) nevertheless, a positive correlation between the share of institutional investors (INST) and the logarithm of total company assets (SIZE), close to the threshold value, should be stated. There is no correlation above the threshold value of 60%, which allows us to reject the problem of multicollinearity between the variables.

Econometric model

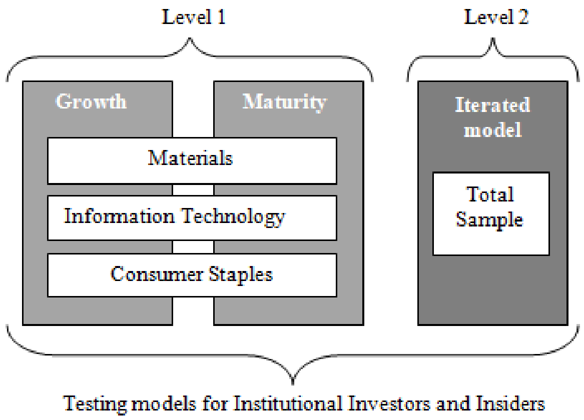
The paper is based on the regression methodology and statistical analysis of panel data where clustered standard error models are applied. Negative binomial regression should also be used in econometric analysis with unobserved cross-sectional heterogeneity to avoid the problem of excessive data variance. The econometric model is analyzed using the sample presented in Fig. 5 at different levels of detail.

The first level involves identifying the life cycle stage, at which the hypotheses are tested. The company cash flow approach is often used to determine the stages of the life cycle. In contrast to other approaches that measure the life cycle through the age of the company, the cash flow approach, according to Dickinson V. is a full-fledged proxy, covering the investment process. Dickinson is a full-fledged proxy, simultaneously covering investment policy, profitability, growth rate, and risks at the company level. Thus, the life cycle stages were defined through operating cash flow (OCF), investment cash flow (ICF), and financial cash flow (FCF) [20]. For analysis, the two most active stages of the life cycle of technological innovations – growth and maturity – are taken into account, and calculated according to the following methodology:

1) The Growth stage, if OCF >0; ICF <0; FCF >0;
2) The Maturity stage, if OCF >0; ICF <0; FCF <0.

At the second level, the analysis of model testing at different levels of sample granularity is carried out, where the first level of granularity involves testing hypotheses about the linear and non-linear relationships between ownership concentration and innovation intensity at the stages of the life cycle: growth and maturity, and the second – models with iterative variables.

Figure 4. Breakdown of the total sample



Source: Author's own calculations and elaborations.

The concentration of ownership in the hands of institutional investors was used as an estimate of ownership concentration in private investors' hands, and the ownership in the hands of insiders was used as an estimate of the share in the hands of insiders. These variables are explanatory in the model. Studying internal factors and identifying significant dependencies allows companies to effectively restructure their corporate governance system to further increase the economic potential and reallocate available resources to invest in R&D. Below is the specification of the regression model with linear dependence for institutional investors:

$$\frac{R\,\&\,D}{NS_{i,t}} = \beta_0 + \beta_1 INST_{i,t} + \beta_2 LVG_{i,t} + \\ + \beta_3 EBTD\_MRGN_{i,t} + \beta_4 SIZE_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $\frac{R\,\&\,D}{NS_{i,t}}$ – R&D to Net Sales;

$INST_{i,t}$ – ownership concentration of institutional investors; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin;

$SIZE_{i,t}$ – logarithm of total assets;

$LVG_{i,t}$ – financial leverage.

A model with linear dependence for insiders was also tested:

$$\frac{R\,\&\,D}{NS_{i,t}} = \beta_0 + \beta_1 INSD_{i,t} + \beta_2 LVG_{i,t} + \\ + \beta_3 EBTD\_MRGN_{i,t} + \beta_4 SIZE_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where $\frac{R\,\&\,D}{NS_{i,t}}$ – R&D to Net Sales;

$INSD_{i,t}$ – ownership concentration of insiders;

$EBTD\_MRGN_{i,t}$ – EBITDA profit margin;

$SIZE_{i,t}$ – logarithm of total assets;

$LVG_{i,t}$ – financial leverage.

The following variables were used as control variables.

Size of the company:

$$\mathrm{SIZE} = \mathrm{LN}(\mathrm{T\_ASSETS}). \quad (3)$$

Financial leverage:

$$\mathrm{LVG} = \frac{Debt}{Equity}. \quad (4)$$

EBITDA profit margin:

$$EBTD_{MRGN} = \frac{EBITDA}{REVENUE} \cdot 100\%. \quad (5)$$

Next, the shareholder ownership structure at different stages of the life cycle was assessed using quadratic dependence. Building on the methodology of the paper, a U-shaped test was used to test the non-linear relationship between R&D investment between the variables.

The specifications of the regression models with quadratic dependence are summarized below.

For institutional investors:

$$\frac{R\,\&\,D}{NS_{i,t}} = \beta_0 + \beta_1 INST_{i,t} + \beta_2 SQUINST_{i,t} + \\ + \beta_3 LVG_{i,t} + \beta_4 EBTD\_MRGN_{i,t} + \beta_5 SIZE_{i,t} + \varepsilon_{i,t}, \quad (6)$$

where $\frac{R\,\&\,D}{NS_{i,t}}$ – R&D to Net Sales;

$INST_{i,t}$ – ownership concentration of institutional investors;

$SQUINST_{i,t}$ – ownership concentration of institutional investors squared;

$LVG_{i,t}$ – financial leverage; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin; $SIZE_{i,t}$ – logarithm of total assets.

For insiders:

$$\frac{R\,\&\,D}{NS_{i,t}} = \beta_0 + \beta_1 INSD_{i,t} + \beta_2 SQUINSD_{i,t} + \beta_3 LVG_{i,t} + \\ + \beta_4 EBTD_{MRGN_{i,t}} + \beta_5 SIZE_{i,t} + \varepsilon_{i,t}, \quad (7)$$

where $\frac{R\,\&\,D}{NS_{i,t}}$ – R&D to Net Sales;

$INSD_{i,t}$ – ownership concentration of insiders; $SQUINSD_{i,t}$ – ownership concentration of insiders squared; $LVG_{i,t}$ – financial leverage; $EBTD \quad MRGN_{i\ t}$ – EBITDA profit margin; $SIZE_{i,t}$ – logarithm of total assets.

Institutional investors and insiders are motivated to spend more on R&D to secure greater long-term financial returns. However, when ownership in a firm increases to a level where owners perceive R&D expenditures as a high risk to their portfolio, R&D expenditures begin to jeopardize savings and as a consequence may lead to the deterioration in the economic potential of the firm. As a result, institutional investors and insiders do not support the additional fundraising initiative, contributing to the reduction of R&D investment. The variables described in formulas (3)–(5) were used as control variables.

A model specification was also used where iterated variables for insiders and institutional investors were used as the main explanatory variables, the specification of this model is shown below.

For insiders:

$$\frac{R\&D}{NS_{i,t}} = \beta_0 + \beta_1 INSDSIZE_{i,t} + \beta_2 LVG_{i,t} + \\ + \beta_3 EBTD_{MRGN_{i,t}} + \beta_4 LNREV_{i,t} + \varepsilon_{i,t}, \quad (8)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$LVG_{i,t}$ – financial leverage; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin; $LNREV_{i,t}$ – logarithm of revenue; $INSDSIZE_{i,t}$ – multiplying of the average of all company assets by the share of stock ownership of insiders.

For institutional investors:

$$\frac{R\&D}{NS_{i,t}} = \beta_0 + \beta_1 INSTSIZE_{i,t} + \beta_2 LVG_{i,t} + \\ + \beta_3 EBTD_{MRGN_{i,t}} + \beta_4 LNREV_{i,t} + \varepsilon_{i,t}, \quad (9)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$LVG_{i,t}$ – financial leverage; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin; $LNREV_{i,t}$ – logarithm of revenue; $INSTSIZE_{i,t}$ – multiplication of the average of all company assets by the share of stock ownership of institutional investors.

The variables described by formulas 3, 4 and 5 and the logarithm of revenue described by formula 10, were used as control variables:

$$\text{LNREV} = \text{LN}(\text{REVENUE}). \quad (10)$$

It is assumed that the larger the firm, the higher the intensity of the effect of ownership concentration on innovation. The companies in the sample have a specific and time-invariant nature, due to the fact that the fixed effects model was chosen. It is considered fixed because it does not affect the dynamics of the behavior of the dependent variable and refers only to the difference between the firms themselves. In contrast, the random effects model assumes that the unobserved characteristics of the firms in the sample change randomly. Moreover, this model allows for the inclusion of time-invariant variables, unlike the fixed effects model, which excludes them through the differentiation process. It is reasonable to expect that differences between firms do affect innovation activity, thus the random effects model should be more robust.

All appropriate checks related to the characteristics of the data should be performed in a regression model with a linear dependence on the total sample before discussing the empirical results.

The heteroscedasticity problem was tested using the Wald test in a fixed effect model, and the p-value was zero, so the homoscedasticity null hypothesis was rejected. An example of a heteroscedasticity test is presented below in Table 7.

Table 7. The Wald test for heteroscedasticity

Chi2	1.5E+38
P-value	0

Source: Author's own calculations and elaborations.

The Wooldridge test for the presence of autocorrelation was used to detect the presence of serial correlation. Since the p-value is 0 in Table 8, the null hypothesis of no autocorrelation is rejected. Cluster standard errors are used to check the heteroscedasticity and autocorrelation in the models. Such standard errors allow for larger confidence intervals because they relax the assumption of correlation between observations, which helps to avoid selecting significant variables that are insignificant.

Table 8. The Wooldridge test for autocorrelation

F (1.2121)	15.907
P-value	0

Source: Author's own calculations and elaborations.

Next, tests show which model specifications (fixed or random effects) are preferred. Using the Lagrange multiplier of the Breusch-Pagan test in Table 9, the significance of the random effects model was shown. Rejection of the null hypothesis means there is a significant difference between the companies, and ordinary OLS regression is not appropriate.

Table 9. The Breusch-Pagan test for Lagrange multiplier

Estimated results	Var	SD
RD_Sales	0.0212736	0.1458548
e	0.0057741	0.0759873
u	0.0257476	0.1604607
Chi2	6775.72	
P-value	0	

Source: Author's own calculations and elaborations.

The Hausman test compared fixed and random effects models. According to the results of the Hausman test in Table 10, the model with random effects is preferable.

Table 10. The Hausman test to verify model specifications

Chi(9)	10.25
P-value	0.33

Source: Author's own calculations and elaborations.

The paper will use panel regression (generalized least squares method) with random effects with cluster errors.

Results

R&D investments contribute to long-term company development, but the costs can also affect income in the short term. It is taking to be that all investors are more involved in monitoring the company management and interested in long-term development respectively. Model testing results are with cleaning of the sample from outliers and omissions in Tables 11–13.

Table 11. Empirical results of regression on the impact of ownership structure on innovative activity for Information Technology industry

Model	Linear model			Iterative model		Quadratic model
Life Cycle	General	Growth	Mature	General		General
Variables	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS
INST	0.0367***	0.0283***	0.0416***			−0.00841
	(0.00443)	(0.00699)	(0.00564)			(0.0109)
SQUINST						0.000529***
						(0.000116)
LVG	0.0298***	0.0185	0.0419***	0.0308***	0.00408	0.0306***
	(0.00941)	(0.0139)	(0.0126)	(0.00939)	(0.00947)	(0.00940)
EBTD MRGN	−0.0198**	0.0620***	−0.0746***	−0.0205**	−0.0139	−0.0193**
	(0.00903)	(0.0153)	(0.0110)	(0.00902)	(0.00892)	(0.00902)
SIZE	−0.790***	−1.289***	−0.434***	−0.957***	−0.480***	−0.784***
	(0.101)	(0.165)	(0.127)	(0.106)	(0.107)	(0.101)
INSTSIZE				0.0299***		
				(0.00316)		
INSDSIZE					-0.0235***	
					(0.00804)	
Constant	9.592***	11.03***	8.421***	10.47***	10.36***	9.990***
	(0.556)	(0.893)	(0.708)	(0.569)	(0.633)	(0.562)
R^2	0.510	0.381	0.285	0.221	0.189	0.525
Obs	5893	2620	3273	5893	5893	5893
Number of Tickers	1750	800	950	1750	1750	1750

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Source: Author's own calculations and elaborations.

Hypothesis 1 about the positive impact of institutional ownership on innovation intensity is not rejected in the IT industry at all stages of the life cycle, and in all industries at the growth stage, but is rejected in the consumer sector. That is because the share of institutional investors in the consumer sector and light and heavy industry sector is more than 35%, while in the IT industry it comprises less than 30%, however, despite the relatively small share, investors are concerned with overcoming corporate problems to normalize and maximize the company's economic performance exclusively in the long run. The low share of institutional investors in the IT industry also acts as a deterrent to absorbing the managerial ambitions of minority shareholders that inhibit the decision-making process in companies. The results for the IT sector have been confirmed in studies of [3].

Table 12. Empirical results of regression on the impact of ownership structure on innovative activity for Consumer Staples industry

Model	Linear model			Quadratic model		Iterative model
Life Cycle	General	Growth	Mature	Growth	Mature	General
Variables	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS
INSD	−0.0110	−0.00207	−0.0445***	−0.00135	0.0651**	
	(0.00861)	(0.0129)	(0.00865)	(0.0314)	(0.0256)	
SQUINSD				−1.33e-05	−0.00252***	
				(0.000537)	(0.000549)	
LVG	0.00135	0.0365	−0.000834	0.0364	−0.000831	0.00103
	(0.0138)	(0.0489)	(0.00673)	(0.0490)	(0.00658)	(0.0121)
EBTD MRGN	0.0108	0.00724	0.00757	0.00719	0.00336	0.00746
	(0.0119)	(0.0213)	(0.0105)	(0.0214)	(0.0105)	(0.0107)
SIZE	−0.0670	−0.0318	−0.0871	−0.0310	−0.0267	0.0794
	(0.0689)	(0.127)	(0.0756)	(0.132)	(0.0772)	(0.0778)
INSTSIZE						−0.00465*
						(0.00245)
INSDSIZE						
Constant	1.657***	1.335	2.112***	1.328	1.485**	0.863*
	(0.493)	(0.877)	(0.559)	(0.932)	(0.580)	(0.464)
R^2	0.311	0.277	0.150	0.451	0.544	0.220
Obs	1718	845	873	845	873	1718
Number of Tickers	940	460	480	460	480	940

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
Source: Author's own calculations and elaborations.

Hypothesis 1.1 about the inverse U-shaped relationship between institutional ownership and innovation intensity is rejected in the consumer and industrial sectors, which demonstrates conflicting results [16], refuting the fact that preferences for risky R&D investments decrease over time, moving into the phase of a conservative investment program with a high payback guarantee for institutional investors. The alternative hypothesis is not rejected in the IT sector in the total sample where the U-shaped relationship is confirmed, as mentioned by [21]. These results are not consistent with economic theory, which states as long as the share of institutional investors is below a certain threshold, the incentives to invest in R&D become higher as the share increases, and the risks become less diversified among investors. On the other hand, the IT sector is a protected industry with operating results that are less sensitive to economic cycles. Thus, risks of losses from R&D investments may be absorbed partly by a more stable financial position. At the same time, the majority of a company's institutional investors company may even incentivize such investment projects at the maturity life cycle phase if their incentives are associated with maintaining a competitive advantage and developing new digital distribution channels, competing with industry disruptors.

Table 13. Empirical results of regression on the impact of ownership structure on innovative activity for Materials industry

Model	Linear model			Quadratic model		Iterative model
Life Cycle	General	Growth	Mature	Growth	Mature	General
Variables	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS
INST	0.00367	0.0181***	–0.00946***			
	(0.00292)	(0.00403)	(0.00338)			
INSD				8.39e-05	–0.0574***	
				(0.0261)	(0.0175)	
SQUINSD				–0.000241	0.00116***	
				(0.000544)	(0.000299)	
LVG	0.0976***	0.0438*	0.118***	0.209***	0.211***	0.0970***
	(0.0153)	(0.0262)	(0.0128)	(0.0611)	(0.0174)	(0.0153)
EBTD MRGN	0.00110	0.000489	–0.00330	0.00823	–0.00234	0.000996
	(0.00729)	(0.00946)	(0.00840)	(0.0117)	(0.0100)	(0.00728)
SIZE	–0.148***	–0.151**	–0.151*	–0.0313	–0.262***	–0.174***
	(0.0548)	(0.0684)	(0.0780)	(0.0772)	(0.0874)	(0.0596)
INSTSIZE						0.00273*
						(0.00164)
INSDSIZE						
Constant	2.386***	1.896***	3.091***	1.980***	4.067***	2.531***
	(0.348)	(0.422)	(0.534)	(0.538)	(0.639)	(0.366)
R^2	0.491	0.364	0.108	0.114	0.484	0.207
Obs	2978	1706	1272	1706	1272	2978
Number of Tickers	552	316	236	316	236	552

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Source: Author's own calculations and elaborations.

Hypothesis 2 about the negative impact of insider ownership on innovation intensity is not rejected in the consumer sector at the maturity stage and IT sector at all stages of the life cycle, while in the industry sector, the hypothesis is rejected at all stages of the life cycle due to lack of significance. In the IT sector, companies invest in R&D throughout the entire life cycle because companies compete for the best technological product. Therefore, the risks of investing in R&D are higher as the future company cash flows depend on the investment outcome. In conditions where board members are also the company's managers (insiders), they assess the risks of losing their current positions or privileges as higher when investing in innovations, and, therefore, the incentive for such investments is reduced. At the same time, for the consumer sector, this effect is significant at the stage of maturity, when insiders' interests do not correlate with the company's interests to maintain competitive advantages and do not move to the stage of decline.

Hypothesis 2.1 regarding the inverse U-shaped relationship between insider ownership and innovation intensity is not rejected at the maturity stage for the consumer sector, while in other sectors, either the alternative hypothesis is accepted (industrial sector), or linear coefficients are not significant for all stages of the life cycle (IT). In contrast, the non-linear relationship type for the consumer sector suggests that the incentives to invest in R&D change as ownership concentration increases, and is linked to the firm's long-term goals when insider ownership concentration is small.

Hypothesis 3, which states that ownership concentration has a stronger effect in large companies, is partly not rejected for the consumer and IT sectors (for institutional owners) in the light and heavy industries, the hypothesis is not confirmed. It is worth noting that in the consumer and IT sectors investors are more frequently faced with the choice of influencing the company through lower monitoring costs. For investors with some business interest in their portfolio companies, monitoring costs are significantly higher than the corresponding costs of independent investment firms. Over time, from the start of the investment, monitoring costs are reduced by accumulated knowledge about the company, as a consequence, large companies can reduce costs on their part for institutional investors by facilitating their access to management and the board of directors. It is confirmed by the empirical analysis by [23] that when a company grows larger, the share of investor ownership increases.

Hypothesis 4, which states that the effect of ownership concentration on the intensity of innovation increases in the transition from growth to maturity life cycle is rejected for the consumer and industry sectors, while for the IT sector, it is true at all life cycle stages. Scientific and technological progress has led to the compression of financial and economic space, given that the most mobile resource for the formation of global financial capital for innovative development is comprised by the funds of institutional investors, which are in free circulation in the economy. Investors favor more stable firms at the maturity stage, as their potential benefits increase with the investment horizon and with the length of shareholding. The regression analysis estimates in Table 10 indicate that the effect of institutional ownership concentration on innovation intensity increases as the firm moves towards maturity as also mentioned in the papers of [24; 29].

Hypothesis 5, which states that ownership concentration has a more pronounced impact in industries with high innovation intensity, is not rejected. It is difficult to compare the impact estimates between sectors with different direct innovation intensities because of the difference in directional effects and lack of significance for similar indicators. First, we test the hypothesis that innovation intensity is statistically higher in IT. The results of regression analysis in Table 11 show that when moving from the consumer to the IT industry, the intensity of innovation increases by 5.4%, and in other cases, results are not significant. Then, it is possible to compare the results of the coefficients in the IT industry with the results for the total sample (Table 10). Indeed, the effect of institutional ownership is amplified in the IT industry in a positive direction and for insider ownership – in a negative direction. This pattern is consistent with the theory that a higher risk of R&D investment in the IT industry increases the agency conflict between owners and managers, and different forms of ownership have a more pronounced effect on the resulting outcome.

Conclusion

In South Asia, investors are more frequently faced with the need to decide how to influence a company by reducing monitoring costs. Expenditure management is significantly higher for investors with a business interest in their portfolio companies than in independent investment firms. Expenditure management is lowered by the accumulated knowledge about the company from the moment the investment is initiated, and as a consequence, large companies can reduce costs for institutional investors by facilitating their access to management and the board of directors. As the company grows, the ownership share of investors increases, which is confirmed by empirical analysis. It is also worth noting the impact of scientific and technological progress, which has led to the compression of the financial and economic space, given that the most mobile resource for the formation of global financial capital for innovative development is comprised by the funds of institutional investors, which are in free circulation in the economy. Investors favor more stable firms at the maturity stage, as their potential benefits increase with the investment horizon and the duration of stock ownership. Estimates from regression analysis demonstrate that the effect of institutional ownership concentration on innovation intensity increases as the firm moves toward the maturity stage.

Companies from different industries attach essential strategic importance to R&D investments to maintain leadership and competitive advantage in creating new technologies of various types – product, process, and marketing or adapting existing technological practices. However, it is worth noting that many research gaps in the study of the impact of different forms of ownership on innovation intensity remain. These research studies are limited to resource theory and agency conflict theory without considering the stages of the life cycle and industry specifics. The results of this paper provide a better understanding of the relationship between the concentration of different forms of ownership and innovation intensity (R&D to Net Sales) with these aspects and thus complement the underlying theories. First of all, a high concentration of institutional ownership has a stimulating effect on innovation intensity in the high-tech IT industry and enhances it in the transition to the maturity stage, moreover, in low-tech sectors it can have a multidirectional effect depending on the stage of the life cycle in the industrial sector and a negative impact in the consumer sector. Secondly, the closer to maturity, the greater the U-shaped dependence relationship in the consumer sector, which is due to the specifics of this industry. Thirdly, the high concentration of insider ownership has a restraining effect on the intensity of innovation for IT throughout the entire life cycle, and at the maturity stage for the consumer sector. At the same time, there is no significant effect on ownership concentration on industry. Fourth, this effect has an inverse U-shaped dependence at the maturity stage in the consumer industry, which is not typical for other sectors. Fifth, for large firms, the high concentration of institutional ownership encourages firms in the consumer and IT industries to maintain a high level of innovation intensity. The hypothesis that high innovation intensity is significantly progressing in the IT industry and that the incentive effect of institutional ownership and the disincentive effect of insider ownership are progressing in these industries is also confirmed. The regularities confirm the actuality of analyzing the industry specifics and drawing conclusions about specific dependences, dividing companies by industry. It is worth noting that the localization of the world leaders' production facilities in R&D investments in different regions is still uneven, which requires consideration of cultural and institutional peculiarities in future studies. Moreover, based on the results, we can see that the impact of various forms of ownership on R&D investment intensity in many ways is determined by the technological complexity of the industry and the life cycle, which is to be considered in future research.

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