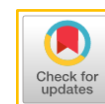


Research and Development (R&D) determination in the Indonesian food and beverage industry



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ARTICLE INFO

ABSTRACT

Received : 22-05-2026

Revised : 24-08-2026

Accepted : 30-08-2026

Published : 27-09-2026

Keywords:

Research & Development (R&D)

Industry Concentration

Indonesian Food Beverage Industry

JEL Classification:

D20; D22; D41

The main objective of this study is to examine the influence of industrial concentration, PCM, company size, Lcosts, workforce size, and foreign ownership on research and development (R&D) expenditure in Indonesia's food and beverage industry from 2017 to 2019. The quantitative investigation employed microdata provided by the Indonesian Central Statistics Agency (BPS). The study applied panel data regression and an instrumental variables approach using Stata 14 software. The findings show that internal firm characteristics, including PCM, company size, and workforce size, positively and significantly influence R&D expenditure. Conversely, Lcosts and foreign ownership negatively affect R&D expenditure, while industrial concentration has no significant influence. These results suggest that the government should maintain competitive market conditions, strengthen human resource quality, and formulate investment policies that promote technology transfer, technological adoption, productivity improvement, and sustainable innovation across firms within the industry.

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1. Introduction

The Indonesian food and beverage industry is a crucial part of the country's manufacturing sector, making a substantial contribution to the national economy. Industrial activity expanded by 8.16 percent, surpassing the average growth of the non-oil and gas processing industry, which reached 4.69 percent from 2015 to 2019. Furthermore, the industry Nworks a significant proportion of the workforce, accounting for approximately 17.4%. The development of the food and beverage industry continues to be driven by increasing domestic demand, population growth, and changes in consumer consumption patterns (Sukmadiana & Faeni, 2025; Chrisnando et al., 2024). Companies are undoubtedly required to foster innovation amidst increasingly fierce competition, as innovation is crucial for maintaining business continuity and enhancing industry competitiveness (Setiadi, 2024; Ciccarelli & de Dominicis, 2025).

Innovation activities are a crucial factor in driving company productivity through research and development (R&D) activities (O'Connell et al., 2022). R&D activities are viewed as a crucial investment that enables companies to produce new products, improve product quality, and refine production processes (Sugiyono, 2016; Santos et al., 2024; Ge et al., 2025). A long-standing theoretical debate between the Schumpeterian and Arrowist hypotheses regarding the direction of

the relationship between market structure and innovation drives research and development (R&D) and industry concentration. Schumpeterian proponents argue that higher industry concentration encourages R&D efforts because large firms with market power have the resources to innovate (Lambertini, 2023), while Arrowists argue that more competitive markets are more conducive to innovation because competitive pressures encourage firms to innovate (Hyun, 2026). A subsequent synthesis by Delbono et al (2020) proposed an inverted-U-shaped relationship, in which R&D increases with competition at intermediate levels of concentration and decreases at both extremes (Lambertini, 2023; Delbono et al., 2020).

The Indonesian debate concerns whether substantial industrial concentration generates inefficiency, as proposed by the quiet-life hypothesis, or instead represents the superior performance of leading firms under the efficient-structure hypothesis. Evidence from the Indonesian food and beverage industry generally favors the quiet-life hypothesis, indicating that greater concentration negatively and unidirectionally affects technical efficiency (Setiawan et al., 2022). In contrast, research covering the wider manufacturing sector supports the efficient-structure hypothesis, suggesting efficient firms expand market shares through competition, thereby leaving an unresolved debate within Indonesia's empirical literature (Esquivias et al., 2020).

R&D activities in companies are not always uniform. Various economic factors and company characteristics are believed to influence a company's decision to invest in research and development (R&D) activities (Lai et al., 2015; Ge et al., 2025). Industry structure is a crucial component related to innovation activities. According to the Structure-Conduct-Performance theory, industry structure plays a crucial role in determining how industry owners conduct themselves, thus influencing company performance (Pramono, 2022). Industries with high concentrations are considered to possess abundant resources and profits, enabling them to invest in research and development (R&D) (Widodo et al., 2015).

The food and beverage (F&B) sector in Indonesia has unique characteristics that distinguish it from other manufacturing sectors, thus requiring a specific innovation approach. The F&B industry is the largest non-oil and gas manufacturing sector in Indonesia, contributing 38.4% to non-oil and gas manufacturing and 6.7% to national GDP in 2021 (Amanta, 2022). This sector is dominated by MSMEs that employ 4.6 million workers, providing livelihoods for many households (Amanta, 2022). Since 2010, the F&B industry has contributed nearly 20% of annual GDP and more than half of Indonesian household expenditure (Setiawan et al., 2022).

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Other factors influencing R&D activities include labor conditions and Lcost levels, which can improve production cost structures and influence a company's decision to invest in innovation (You et al., 2023; Moretti et al., 2025; Huong & Thanh, 2024). Furthermore, foreign ownership is often associated with increased innovation activity. Companies that receive foreign investment generally have broader opportunities for technological advancement, global networks, and more advanced management practices (Do, 2024). Through technology and knowledge transfer mechanisms, foreign ownership is believed to encourage increased R&D activities within the company (Chen et al., 2022).

Nevertheless, empirical evidence shows that R&D activity in the industrial sector in developing countries, including Indonesia, remains relatively limited compared to developed countries (Setiawan et al., 2021; Fayyaz & Bartha, 2025). Approximately 80–90% of R&D funding in Indonesia comes from government budgets and public universities, while private sector contributions are very limited (Putera et al., 2025; Sudaryanto et al., 2024). In 2018, 83.7% of R&D came from government funds and only 16.3% from non-government sources, indicating an extreme dependence on the state budget (Triyono, 2020). The industrial sector's contribution to the Gross Expenditure on R&D (GERD) ratio is only around 7.34–29.5%, a percentage that has not shown improvement over time (Hidayati et al., 2022; Putera et al., 2025).

This gap underscores the need to specifically examine the determinants of R&D activity in the Indonesian food and beverage industry. Previous studies have addressed the determinants of innovation activity (Setiawan et al., 2021; Wijaya et al., 2025), but research focused on this sector, particularly studies that simultaneously consider industry structure and firm characteristics, remains limited. Furthermore, most previous studies employ conventional regression approaches and ignore the potential endogeneity between market structure and firm innovation activity (Lee et al., 2022). Based on the above description, the existence of research problems is important to study. Therefore, the purpose of this study is to analyze the determinants of R&D activities in the Indonesian food and beverage industry from 2017 to 2019, considering the influence of industry concentration, Price-Cost Margin, company size, Lcost levels, number of workers, and foreign investment or ownership. The data used in this analysis are firm-level microdata and an econometric approach that addresses potential endogeneity through the instrumental variable method. The novelty of this study lies in its focus on the Indonesian food and beverage industry, the integration of industry structure and firm characteristics within a single analytical framework, and the application of an instrumental variable approach to provide more robust evidence on the determinants of firms' R&D activities.

2. Literature Review

2.1. Research and Development (R&D)

Research and development (R&D) constitutes a systematic process for generating new products, improving existing products, and evaluating their effectiveness (Sugiyono, 2016). From the perspective of endogenous growth theory, economic growth originates from internal economic forces, the accumulation of knowledge, human capital, and innovative ideas (Shaw, 2025). The Schumpeterian hypothesis argues that larger firms tend to conduct more R&D because their greater financial capacity enables them to bear substantial research expenditures and technological investment (Setiawan et al., 2021). A firm's capacity to innovate is closely associated with the effectiveness of its R&D activities and the availability of highly skilled labor, both of which can strengthen its innovative performance (Garzón Delvaux et al., 2018). Innovation also represents an important source of economic and social progress; consequently, R&D investment plays a strategic role in strengthening national competitiveness, technological capabilities, and productivity (Ciccarelli & de Dominicis, 2025).

Empirical evidence indicates that firms undertaking R&D activities achieve sales growth approximately three percent higher than firms that do not conduct such activities (Setiawan & Harmasanto, 2019). This finding indicates that R&D investment enables firms to develop advanced technologies and strengthen human capital, which subsequently provides competitive advantages through product innovation and improvements in production processes (Zaman & Tanewski, 2024). Moreover, R&D undertaken to develop new products and innovations may create knowledge spillovers that generate benefits for other economic actors. Consequently, sustained investment in innovation can support a positive long-term economic growth trajectory by strengthening incentives for continuous technological progress (Shaw, 2025).

2.2. Industry Concentration

Industry concentration refers to the degree to which a small number of firms dominate total output, sales, or assets within an industry (Lynne et al., 2018). The Structure, Conduct, and Performance theory posits that industry structure plays a crucial role in determining how industry owners conduct themselves, thus influencing firm performance (Pramono, 2022). Industry concentration is also an indicator of industry structure. Industry concentration refers to the extent to which large firms hold a significant market share within an industry. Furthermore, firms with a high concentration of activity can influence risky corporate decision-making and government policy (Bajgar, et al, 2023). The higher the concentration, the greater the market power of large firms in setting prices and influencing market control.

Industry concentration increases as firms shift to technologies with high returns to scale (Covarrubias et al., 2020). Firms with higher productivity and advanced technologies will gain greater market share, thus industry concentration reflects technological change and globalization (Bajgar et al., 2023). This finding suggests that when firms are highly concentrated, they invest more in R&D (Widodo et al., 2015). Furthermore, while industry concentration can mitigate the negative impact of supply chain concentration on firms' R&D investment, financing constraints exacerbate this negative

impact (Zhao et al., 2025). Therefore, a high degree of concentration within a company may foster increased R&D activities. Since R&D expenses are often substantial, firms require strong incentives to pursue innovation.

2.3. Price Cost Margin (PCM)

The PCM represents the difference between the output price and the marginal cost of production, which is an indicator of market power (Setiawan et al., 2021). A larger firm's PCM indicates a larger difference between its price and production costs, meaning the firm is able to set prices above its production costs (Belleflamme et al., 2022). Within the Structure, Conduct, and Performance framework, the PCM is also often used as a measure of industry performance (Bain, 1956). Companies with high profit margins certainly have more adequate resources to fund R&D activities and, as a strategy to increase competitiveness in maintaining their market position (Mayuni et al., 2024). Furthermore, companies with good financial performance are certainly more likely to invest in innovation, with sufficient internal funding sources being a determining factor in financing these activities (Kruglov & Shaw, 2024). Companies with greater financial capacity tend to be more active in investing in R&D because they can afford the relatively high costs and risks of these activities (Judijanto, 2024).

Industries with high concentration indicate that a few large firms tend to possess monopoly or oligopoly power. This power allows each industry to set higher prices due to low competition, resulting in higher profits or price-to-cost margins (PCM) (Grullon et al., 2019). Furthermore, when the Price-Cost Margin (PCM) is used, stronger R&D spillovers occur among firms operating under low competition (Singh, 2022). Concentration and profit margins have a positive and significant impact on profitability and product prices (Ridhwan et al., 2025). A company with substantial profits naturally has the internal financial capacity to support innovation and research projects. Profitability acts as a mediator between financial performance and technology investment decisions, with companies with high profit margins being more willing to undertake long-term R&D expansion (Wang et al., 2024; Brunner et al., 2024). PCM is also an important determinant of R&D expenditure and intensity. Furthermore, PCM has a positive impact on a company's R&D expenditure (Setiawan et al., 2021).

2.4. Company Size

Company size is a scale that indicates the size of a company, as measured by total assets, sales, stock market value, or number of workers (Hartono, 2000). Companies with a large production scale can certainly undertake investment activities, thus enabling the company to expand its business, including investing in technology and innovation. According to the theory of economies of scale, increasing production scale can reduce average costs and enhance efficiency. Large companies typically display a positive, linear efficiency curve, such that greater scale leads to continuously rising efficiency (Chen et al., 2023). Operational efficiency and process quality strengthen the economic benefits of R&D investment, particularly in firms with complex operations (Yiu et al., 2020). Firms with higher efficiency are more capable of conducting R&D, as superior resources, technology, and management support innovation activities.

However, on the other hand, size is not always a determinant in increasing innovation activity (Pambudi et al., 2025). This shows that when companies allocate large funds to R&D, these activities actually experience a temporary decline in performance due to the high research costs they must bear (Susanto et al., 2024). Thus, innovation activity is influenced not only by a company's size but also by other factors such as innovation culture, organizational structure, and management strategy. Furthermore, R&D expenditures do not always improve company performance in the short term because R&D activities require a long time to generate economic benefits. However, R&D expenditures have a positive impact on firm value and company size (Hutauruk, 2024). Investment in R&D plays a crucial role in driving firm performance, value, and productivity, particularly in firms with greater resource capacity (Santos et al., 2024; Saharti, 2025). Furthermore, broader access to funding and better research infrastructure are characteristics of larger firms, enabling them to increase innovation activities compared to smaller firms (Yuliyanti, 2024). This suggests that R&D-based innovation is a crucial factor in improving operational performance.

2.5. Labor Cost

Labor expenditures are costs incurred by a company to pay for the physical or mental effort expended in producing a product. Physical effort is usually performed by workers directly involved

in production activities, while mental effort relates to intellectual abilities such as planning, supervision, and development of production processes. According to Efficiency Lcost Theory, large companies or those with high market dominance tend to pay higher Lcosts to maintain productivity and reduce turnover (Shapiro & Stiglitz, 1984). However, Lcost increases can increase a company's operating costs and limit innovation investment due to budget constraints (Južnik, 2022). Furthermore, the theory of the financially constrained firm suggests that companies with limited resources tend to reduce innovation investment when cost pressures increase (Brunner et al., 2024). Furthermore, budget constraint theory also suggests that companies have limited financial resources and must prioritize fund allocation between operating costs and innovation investment (Kuga, 1996).

Labor market pressures can cause Lcost distortions and affect innovation efficiency and firms' R&D investment decisions. When labor costs increase, firms may adjust their innovation strategies by reducing or postponing R&D spending (Onyekwere, 2019). Furthermore, R&D is a factor of production in a firm's production function, so the allocation of R&D funds is significantly influenced by input costs, including labor. This suggests that changes in factor prices can influence firms' innovation investment decisions (Onyekwere, 2019). Furthermore, high Lcost pressure actually encourages investment and increases corporate R&D spending (You et al., 2023; Moretti et al., 2021). This means that when labor costs rise, companies face pressure to maintain efficiency and competitiveness in the market. One strategy that can be implemented is to develop new technologies, improve production processes, and create innovation through R&D activities. Thus, rising labor costs will force companies to face higher production costs, prompting them to seek more efficient alternatives. One approach is through the development of technology and innovation that can partially replace labor in the production process. Investment in R&D is also a strategy used by companies to improve operational efficiency, reduce production costs, and increase productivity through the use of more advanced technology.

2.6. Number of Workers

The number of workers is the human resources used in the production process to produce goods and services (Todaro & Smith, 2015). The number of workers plays a crucial role in economic activity because, without them, the production process cannot run optimally. Furthermore, the quality and number of workers can also influence the level of productivity and the success of a production activity. Endogenous Growth Theory emphasizes that investment in human capital and R&D activities are key drivers of economic growth (Juhro & Trisnanto, 2018). This is reflected at the company level, where the ability to generate innovation is highly dependent on the R&D function and the availability of a highly skilled workforce (Ochoa & Ramirez, 2018). Therefore, R&D activities are a crucial aspect for companies in increasing innovation and competitiveness, including in the food and beverage industry in Indonesia.

The number of workers in a company has a positive effect on product innovation. Companies with a larger number of workers are more likely to innovate due to their greater human resource capacity for developing new products (Huong & Thanh, 2024). Furthermore, workforce structure and workforce skills are important factors in the technological innovation process. Companies with a larger and more skilled workforce tend to be more active in technology development and innovation (Hang et al., 2024). Furthermore, a company's innovation activities are closely linked to the condition of its workforce. Innovation can boost workforce productivity and demonstrate that workforce presence is a crucial element in a company's R&D process (Sime & Tadesse, 2025). Therefore, the number of qualified workers is a crucial factor in driving a company's R&D activities.

2.7. Foreign Ownership

Foreign ownership denotes the participation of overseas individuals or institutions in a firm's equity in the host economy. In empirical studies, this concept is represented by the proportion of shares controlled by foreign investors, reflecting the extent of their involvement in corporate ownership (Phan, 2024; Tran et al., 2023; Roedder & Schmid, 2025). Firms with foreign participation may allocate resources to R&D because they can obtain capital, technology, managerial expertise, and knowledge through international networks (Do, 2024). Access to these resources can facilitate the adoption and development of new technologies, improve production processes, and strengthen firms' capacity to compete. Foreign participation may therefore create conditions that encourage firms to undertake innovation-oriented activities and improve their productivity and market performance (Xu et al., 2022).

Previous empirical evidence also indicates that foreign ownership can be associated with higher R&D expenditure. Foreign investors may promote longer-term strategies and provide organizational practices that support technological development and firm competitiveness (Ferris & Park, 2005). In addition, their involvement may strengthen corporate governance and managerial efficiency, thereby creating a more supportive environment for innovation and creativity (Kong et al., 2020). Foreign enterprises can account for a significant share of national R&D activities while transmitting knowledge and technologies to domestic firms through technological spillovers (Wang & Henning, 2025). The transfer of knowledge, technology, and managerial capabilities from foreign parent companies can increase the likelihood that foreign-owned firms undertake R&D activities. These advantages may enhance productivity, product quality, and competitive strength, allowing firms to expand their market positions. Greater competitive advantages may subsequently contribute to industrial concentration (Sarker, 2022; Insee & Suttipun, 2023). Accordingly, foreign ownership is expected to stimulate R&D through access to international resources, knowledge transfer, and technological capabilities, supporting innovation and improvements in production efficiency.

2.8. Conceptual Framework

Drawing from theoretical perspectives and earlier empirical evidence, firms' decisions to engage in Research and Development (R&D) can be understood through three principal dimensions: market incentives, organizational capacity, and costs and technology. Together, these dimensions capture market conditions, internal firm capabilities, and the cost and technological environment that shape how firms determine whether to commit valuable resources toward R&D activities and innovation efforts for future innovation, productivity, and competitiveness.

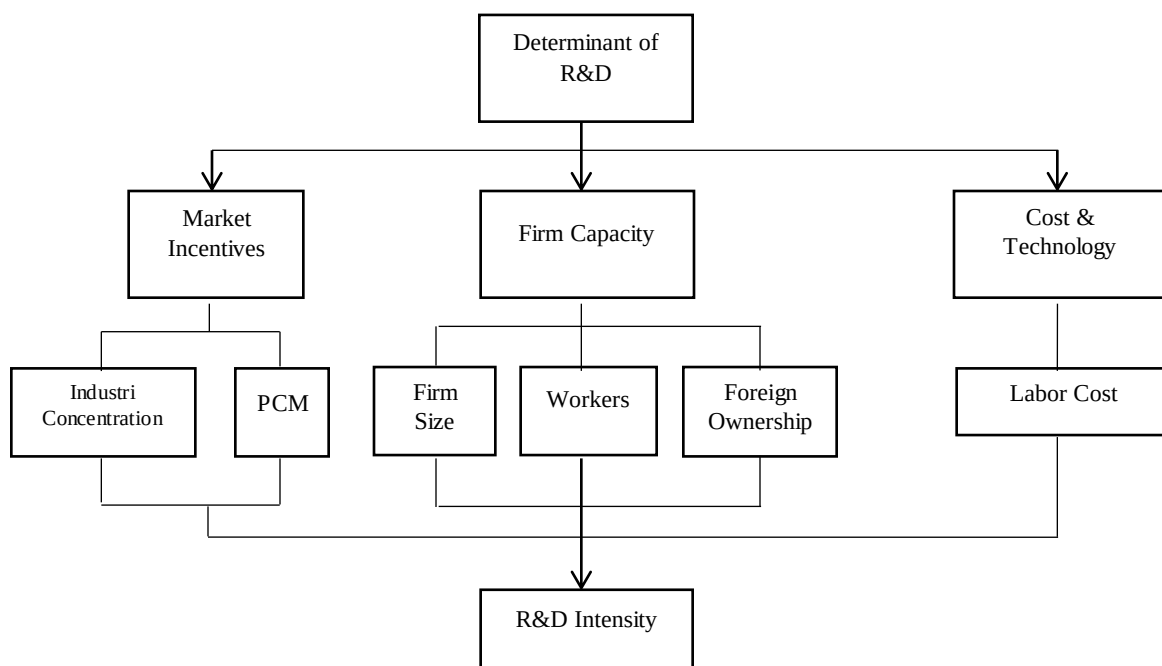


Figure 1. Conceptual Framework

Figure 1 shows The downward arrow (↓) shows the influence of market incentives, firm capacity, and cost and technology on R&D intensity; Market incentives consist of industry concentration (IC) and PCM; Firm capacity consists of firm size, workers, and foreign ownership; Labor costs represent cost and technology; and All of these factors ultimately influence R&D intensity. Based on these literature the following hypothesis as follows:

- H1 PCM has a positive effect on R&D.
- H2 Industrial Concentration has positive effect on R&D.
- H3 Company size has a positive effect on R&D.
- H4 Labor Costs have a positive effect on R&D
- H5 The number of workers has a positive effect on R&D
- H6 Foreign Ownership has a positive effect on R&D

3. Method

This research investigates factors associated with corporate R&D engagement within Indonesia's food and beverage manufacturing sector during 2017–2019. Firms operating in this sector constitute the study's analytical units. The research employs firm-level microdata obtained from the Large and Medium Manufacturing Industry Survey (IBS) administered by Statistics Indonesia (BPS). The dataset provides detailed information regarding individual firm attributes, production expenditures, labor utilization, and R&D-related activities, enabling an empirical assessment of factors influencing companies' involvement in research and development. All variables used in the analysis are on a ratio scale. The dependent variable is transformed into a natural logarithm to reduce heteroscedasticity and non-normal data distribution. Meanwhile, several independent variables are expressed in real values obtained from the deflation process through the Wholesale Price Index (IHPB) using the 2010 base year. The variables used in this study presented in Table 1.

Table 1. Sector Codes for Aggregated Input-Output Table

No	Variable	Definition	Measurement
1	R&D (RD)	Company expenditure on research and development activities	Natural logarithm of R&D expenditure
2	Industry Concentration (IC)	Level of market concentration within an industrial subsector	Measured using the Four-Firm Concentration Ratio (CR4)
3	Price Cost Margin (PCM):	An indicator of a company's market power	Natural logarithm of (value added – Labor Cost + beginning inventory) / output + ending inventory
4	Company Size (Company size)	Scale of a company's production activities.	Natural logarithm of the total value (rupiah) of the company's production
5	Labor Costs (Lcost).	Company expenditure on labor	Natural logarithm of production worker expenditure + other worker expenditure/total workers
6	Number of Workers (Nwork)	Number of production workers in the company	Natural logarithm of the total number of production workers
7	Foreign Ownership (Fown)	Foreign ownership status	Dummy (1 = foreign-owned company, 0 = domestically owned company)

The operational definitions of all variables are consistent with the firm-level information available in the Annual Survey of Large and Medium Manufacturing Industries (IBS) conducted by Statistics Indonesia (BPS). The variables used in this study were constructed from the corresponding data components provided in the IBS dataset. Industry concentration was calculated by the authors using firms' market shares within each industrial subsector, while the remaining variables were derived from firm-level information available in the survey data.

Table 2. Data Sources

No	Variable	Data Source	Data Availability
1	R&D (RD)	Large and Medium Manufacturing Industry Survey (IBS), Statistics Indonesia (BPS)	2017–2019
2	Industry Concentration (IC)	Calculated from IBS firm-level data, BPS	2017–2019
3	Price Cost Margin (PCM)	IBS, BPS	2017–2019
4	Company Size (FSize)	IBS, BPS	2017–2019
5	Labor Costs (Lcost)	IBS, BPS	2017–2019
6	Number of Workers (Nwork)	IBS, BPS	2017–2019
7	Foreign Ownership (Fown)	IBS, BPS	2017–2019

Table 2 show the sources of the data and this study applies a panel data regression analysis model to estimate the determinants of research and development (R&D) activities. The analysis model used in the panel data regression process is as follows:

$$RD_{it} = \alpha + \beta_1 IC_{it} + \beta_2 PCM_{it} + \beta_3 Csize_{it} + \beta_4 Lcost_{it} + \beta_5 Nwork_{it} + \beta_6 FOwn_{it} + \varepsilon_{it} \quad (1)$$

Where i represents a firm in the food and beverage industry; t denotes the observation period from 2017 to 2019; RD represents research and development activity; IC denotes industrial concentration measured by CR4. PCM refers to Price Cost Margin; $Csize$ represents firm size, measured by production output (rupiah); $Lcost$ denotes labor expenditure; $Nwork$ indicates the number of production employees; $FOwn$ represents foreign ownership status; ε denotes the random disturbance term. The dataset employed in this study consists of cross-sectional observations from food and beverage industry firms and time-series observations covering 2017–2019. Therefore, the estimation procedure applies a panel data regression framework for this analysis. Panel data can generally be estimated using three main models, namely the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The appropriate estimation model is subsequently identified through several statistical tests. The Chow test is initially conducted to assess whether the pooled or fixed effect model is more suitable. Subsequently, the Hausman test is applied to determine the appropriate choice between the fixed effect and random effect models. The Breusch-Pagan Lagrange Multiplier (LM) test is then used to evaluate whether the pooled OLS or random effect model should be selected. However, when the Chow and Hausman tests consistently indicate one estimation model, that model can be considered the most appropriate, making the LM test unnecessary (Basuki & Prawoto, 2016).

In this study, the IC and PCM market concentration variables are suspected to be endogenous due to their reciprocal relationship with the R&D variable. For example, a concentrated industry structure can encourage firms to increase R&D spending, while increased R&D can also change the market structure and level of industry concentration. This endogeneity can lead to biased estimates when using conventional estimation methods. To address the endogeneity issue in the IC and PCM variables, the Two-Stage Least Squares (2SLS) method was used with the following instrumental variables and First-Stage regression for Industrial Concentration (IC) as follows:

$$IC_{jt} = \pi_0 + \pi_1 ACOR_{jt} + \pi_2 MSize_{jt} + \alpha_i + v_{it} \quad (2)$$

Where IC_{jt} is the market concentration in the food and beverage industry subsector j in year t ; $ACOR_{jt}$ is the average ratio of capital to output in an industry; $MSize_{jt}$ is the natural logarithm of total output per firm in a subsector; α_i is the fixed effects on each sub-sector of the food and beverage industry I and v_{it} is the error term. Data are taken from annual panel observations of companies. Year dummies are used to capture time effects. The results of this model will be used as instruments in the second-stage regression. The equation for price cost margin as follows:

$$PCM_{jt} = \delta_0 + \delta_1 COR_{jt} + \delta_2 Dgov_{jt} + \alpha_i + v_{it} \quad (3)$$

Where PCM_{jt} is the Price Cost Margin of food and beverage Industry j in year t ; COR_{jt} is the Ratio of capital to output of a firm; $Dgov_{jt}$ is the dummy for firms with government ownership; α_i is the fixed effects per industry and v_{it} is the error term. For the second stage regression as follows:

$$R\&D_{it} = \alpha_i + \beta_1 \widehat{IC}_{jt} + \beta_2 PCM_{it} + \beta_3 Csize_{it} + \beta_4 Lcost_{it} + \beta_5 Nwork_{it} + \beta_6 FOwn_{it} + \tau_t + \varepsilon_{it} \quad (3)$$

Where $R\&D_{it}$ is the research and development (R&D) intensity in the food and beverage industry subsector i in period t ; $\widehat{IC}_{jt}$ is the predicted results from Model 1; $Csize_{it}$ is the firm size; $Lcost_{it}$ is the labor costs; $Nwork_{it}$ is the number of employees; $FOwn_{it}$ is the foreign ownership; τ_t is the year for fixed effect and ε_{it} is the error term.

3. Results and Discussion

4.1. Descriptive Statistics

Descriptive statistics summarize the observed data and offer a general picture of the characteristics associated with the variables examined in this research (Mishra et al., 2019). Table 3 reports the mean, standard deviation, minimum, and maximum for all variables incorporated into the analysis. Table 3 shows the average R&D value reaches 8.696, accompanied by a standard deviation of 2.837, suggesting substantial differences in research and development intensity across firms. The minimum observation is zero, whereas the maximum reaches 20.448, demonstrating that R&D activities are not undertaken uniformly by every Company. The CR4 variable records an average of 0.188, reflecting a relatively low to moderate degree of industrial concentration. However, its maximum value of 0.702 suggests that several industries experience considerably stronger market concentration.

For PCM, the average value is 8.667, while its standard deviation reaches 4.495, showing considerable variation in profitability across companies. Furthermore, Csize has a mean of 0.340 and a standard deviation of 0.593. These figures reveal that companies differ substantially in terms of their operational scale and production activities. Overall, these variations also demonstrate heterogeneity in operational capacity, production scale, and business characteristics among firms within the observed sample considerably. Descriptive statistics provide an overview of the distribution and characteristics of the empirical data used in this study (Mishra et al., 2019). Table 3 presents four descriptive measures, namely the mean, standard deviation, minimum, and maximum values, for each variable included in the empirical analysis.

Table 3. Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
R&D	8.695	2.837	0	20.448
CR4	0.188	0.103	0.076	0.702
PCM	8.666	4.494	-3.506	20.276
Csize	0.340	0.593	0	5.795
Lcost	4.491	1.442	-2.098	10.288
Nwork	4.140	1.077	2.995	9.782
Fown	0.620	0.485	0	1
Acor	1.311	1.185	0.042	9.622
Msize	-0.033	0.816	-3.157	2.264
Dgov	0.123	0.329	0	1
Cor	2.335	1.948	0.336	18.381

Source: data processed

Table 3 shows R&D has a mean value of 8.696 and a standard deviation of 2.837, indicating notable variation in R&D intensity among the observed firms. Its minimum value is zero, while the maximum reaches 20.448, implying that firms differ considerably in their engagement with R&D activities. Meanwhile, CR4 has an average value of 0.188, indicating a generally low to moderate level of market concentration across industries. Nevertheless, the maximum value of 0.702 indicates that certain industries are characterized by substantially higher concentration levels. The PCM variable has a mean of 8.667 and a standard deviation of 4.495, indicating considerable differences in profitability among firms. Csize records a mean of 0.340 with a standard deviation of 0.593, reflecting variation in firm scale and production capacity. Taken together, the descriptive results indicate considerable heterogeneity among firms regarding R&D intensity, market structure, profitability, operational scale, and production characteristics within the sample.

4.2. Model Selection

This study applies the Chow, Hausman, and Breusch-Pagan Lagrange Multiplier tests to identify the most suitable panel data estimation approach. These procedures are conducted to evaluate whether the selected model adequately represents the characteristics of the panel dataset. The findings obtained from the Chow and Hausman tests are presented in the following section:

Table 4. Chow and Hausman Test Results

Components	Uji Chow	Components	Uji Hausman
F-statistic	1.68	Chi-square	7422.24
df	(4119, 1808)	df	5
Prob > F	0.0000	Prob > chi ²	0.0000

Source: data processed

Table 4 shows the model selection results in the table above show that the Chow test has an F-statistic and probability value of 1.68 and 0.000, respectively. This indicates that FEM is more appropriate than CEM due to its probability value being less than the five percent significance level. The null hypothesis (H0) stating that CEM is more appropriate than FEM is rejected. Moreover, the Hausman test produces a Chi-square statistic of 7422.24 with a Prob > chi² value of 0.0000, which is below the five percent significance threshold. These findings provide sufficient evidence to reject the null hypothesis that the Random Effect Model (REM) is preferable. Hence, the Fixed Effect Model (FEM) is considered more suitable for estimating the panel regression model. In addition, the Chow and Hausman tests both result in the selection of FEM as the preferred estimation approach. Since these two specification tests consistently support the use of FEM, conducting the Lagrange Multiplier (LM) test is unnecessary. The LM procedure is primarily employed to assess whether the Common Effect Model (CEM) or REM should be selected (Gujarati & Porter, 2009). Thus, FEM is retained as the appropriate model for subsequent panel data estimation.

4.3. Fixed Effect Model (FEM) Estimation

This estimation process aims to examine the relationship between independent and dependent variables using the Fixed Effect Model approach. This test aims to control for the effects of unobserved but fixed heterogeneity within each Observation unit (Gujarati & Porter, 2009). Firm characteristics that remain unchanged over time can be controlled through this approach, resulting in more accurate estimation results.

Table 5. Fixed Effect Model (FEM) Estimation Results

Independent Variable	Dependent Variable: R&D	
	Koefisien	
CR4	-0.488	(0.401)
PCM	0.205***	(0.008)
Csize	0.926***	(0.163)
Lcost	-1.104***	(0.115)
Nwork	0.791***	(0.184)
Fown	-0.428*	(0.251)
Constanta	8.402***	(0.783)

Source: data processed

Table 5 show the variables profit margin (PCM), Company size (Csize), and total Nworkment (Nwork) have positive and significant effects. Conversely, labor Lcosts (Lcost) and foreign ownership (Fown) have negative and significant effects. However, variable CR4 does not show a significant effect at the conventional level on R&D in the Indonesian food and beverage industry. This model is used as a baseline estimation to control for fixed heterogeneity at the firm level. However, due to the potential for endogeneity in several variables in the study, subsequent analysis used the Instrumental Variables (IV) method to obtain more consistent estimates.

4.4. Instrumental Variable (IV)

Estimation using the Instrumental Variable (IV) method is conducted to address potential endogeneity issues caused by conditions where the independent variable and error term have a reciprocal relationship, resulting in biased and inconsistent analysis results (Wooldridge, 2013). The IV test was conducted using the Underidentification test, Weak Identification test, and Overidentification test (Hansen J Test). Table 6 show The Kleibergen-Paap rk LM statistic was employed to assess whether the model was underidentified. The resulting statistic was 43.96, accompanied by a p-value of 0.000. This significant result suggests that the instruments were sufficiently correlated with the endogenous regressors, supporting the identification of the estimated model. Subsequently, instrument strength was evaluated through the Cragg-Donald Wald F statistic and the Kleibergen-Paap rk Wald F statistic. The corresponding F statistics were 13.21 and 13.12,

respectively. Both statistics exceeded the relevant Stock-Yogo critical thresholds for 10 percent and 5 percent relative bias, providing evidence that the instruments possessed adequate explanatory strength and that weak-instrument concerns were not substantial.

Table 6. Results of First Stage and Second Stage Diagnostic Tests of Model IV

Test Type	Statistics	Value
Underidentification test	Kleibergen Paap rk LM	43.96***
Weak identification test	Cragg Donald Wald F	13.21
Weak identification test	Kleibergen Paap rk Wald F	13.12
Overidentification test	Hansen J statistic	0.389
Weak-IV robust test	Anderson Rubin Wald F	73.96***
Weak-IV robust test	Stock Wright LM S	217.44***

Source: data processed

Moreover, instrument exogeneity was examined through the Hansen J overidentification test, which evaluates whether the instruments are independent of the structural error term. The test produced a Hansen J statistic of 0.389 and a p-value of 0.8232. Therefore, the null hypothesis of instrument validity could not be rejected, implying that the instruments satisfy the required exogeneity condition. Finally, robustness to potential weak-identification concerns was assessed using the Anderson-Rubin Wald test and the Stock-Wright LM S statistic. Both procedures produced a p-value of 0.000, indicating that the endogenous regressors were jointly significant in determining the dependent variable. Overall, these robustness results strengthen confidence in the estimated relationship despite potential weak-instrument concerns. These findings support the reliability of the instrumental-variable estimation results presented in this empirical study.

4.5. First Stage Regression

The first stage in the IV-2SLS method is to conduct a first-stage regression to test the relevance of the instrumental variables in explaining the endogenous variables, namely CR4 and PCM.

Table 7. First Stage Regression Results

Independent Variable	Dependent Variable: R&D	
	CR4	PCM
Acor	0.0062 (0.0043)	-0.1868 (0.1793)
Msize	-0.0178*** (0.0066)	0.6901*** (0.2223)
dgov	0.0358*** (0.0063)	6.7918*** (0.1152)
Cor	0.0051*** (0.0011)	-0.5479*** (0.0627)
Csize	-0.0170* (0.0091)	0.4171 (0.3238)
Lcost	0.0027 (0.0067)	1.3375*** (0.2519)
Nwork	0.0104 (0.0086)	-0.3945 (0.3421)
Fown	0.0074 (0.0152)	1.8129*** (0.4613)
Observations	3.510	
Number of groups	1.696	
F-test excluded instruments (CR4)	12.86	
F-test excluded instruments (PCM)	1636.79	
Sanderson-Windmeijer F-test	19.51; 163.18	

Note: Standard errors are in parentheses. Estimates use fixed effects with robust standard errors and clustering at the ID level. *** p < 0.01, ** p < 0.05, * p < 0.10.

Table 7 show the regression results for CR4 reveal that some explanatory factors significantly determine industrial concentration. Specifically, $\ln_Msize$ and $\ln_Csize$ exhibit negative coefficients,

with significance at the one percent and 10 percent thresholds, respectively. These results suggest that expansion in market scale and company scale is associated with lower levels of concentration. In contrast, *dgov* and *cor* display positive and statistically significant coefficients at the one percent level, implying that stronger government involvement and *cor* are associated with greater concentration. Meanwhile, *acor*, *Lcost*, *Nwork*, and *Fown* show no statistically meaningful relationship with *CR4* within the observed Indonesian industrial sectors.

For the PCM specification, *ln_Msize*, *dgov*, *Lcost*, and *Fown* are positively associated with profit margins, each reaching significance at the one percent level. Thus, larger markets, greater government involvement, higher *Lcost*, and foreign ownership are linked to improved PCM. Conversely, *cor* has a negative and significant coefficient, suggesting that higher *cor* is accompanied by lower profit margins. The coefficients of *acor*, *ln_Csize*, and *Nwork* are statistically insignificant in explaining PCM. Furthermore, the instrument strength test for the model showed adequate results. The *CR4* and PCM models had F-test values for excluded instruments of 12.86 and 1636.79, respectively, both greater than the general minimum threshold of $F > 10$. This indicates that the instruments used are sufficiently robust and do not experience weak instrument problems. Furthermore, these results were reinforced by the Sanderson-Windmeijer multivariate F-test, which showed the *CR4* model had a value of 19.51 and the PCM model 163.18, further confirming that the instruments used are relevant in explaining the endogenous variables. Overall, the first-stage estimation results indicate that the instruments used in the model meet the requirements for instrument relevance.

4.6. Second Stage Regression

The second stage aims to estimate the influence of endogenous variables on the dependent variable using the predicted values obtained from the first stage. Table 8 shows the *CR4* coefficient is negative (-2.110), although it is not statistically significant. This finding indicates that, after controlling for endogeneity in industrial concentration, higher market concentration does not necessarily encourage firms to increase R&D activity. From an economic perspective, this result suggests that the existence of a highly concentrated market does not automatically create stronger incentives for innovation. This result is particularly relevant in the context of Indonesian manufacturing, where firms with substantial market shares may be able to maintain profitability through their existing market position without necessarily relying on innovation activities.

Table 8. Second Stage Results (IV 2SLS Estimation)

Independent Variable	Koefisien
<i>CR4</i>	-2.110 (2.377)
PCM	0.223*** (0.013)
<i>Csize</i>	0.907*** (0.242)
<i>Lcost</i>	-1.133*** (0.179)
<i>Nwork</i>	0.813*** (0.210)
<i>Fown</i>	-0.429 (0.367)
Observation	3510
Cluster (id)	1696
F-statistic	56.27
Prob > F	0.000
R ²	0.2996
Root MSE	1.684

Source: data processed

the *CR4* coefficient is negative (-2.110), although it is not statistically significant. This finding indicates that, after controlling for endogeneity in industrial concentration, higher market concentration does not necessarily encourage firms to increase R&D activity. From an economic perspective, this result suggests that the existence of a highly concentrated market does not automatically create stronger incentives for innovation. This result is particularly relevant in the context of Indonesian manufacturing, where firms with substantial market shares may be able to

maintain profitability through their existing market position without necessarily relying on innovation activities.

Regarding the control variables, company size (Csize) demonstrates a positive and statistically significant relationship with R&D intensity. The finding implies that larger firms tend to allocate more resources to R&D activities. From an economic perspective, large firms possess stronger financial capabilities, better opportunities to obtain external funding, and greater ability to manage the uncertainty and risks inherent in R&D. Moreover, larger firms can obtain economies of scale in innovation because fixed expenditures for research facilities, laboratories, technology, and skilled personnel can be spread over a broader production base overall. Labour cost (Lcost) has a negative and statistically significant effect on R&D intensity. This result indicates that rising labour expenditure can restrict firms' capacity to allocate resources toward research and development. When labour expenses increase, a larger share of revenues may be absorbed by production costs, leaving fewer resources for innovation activities that generate returns. This situation may matter for firms experiencing financial constraints. Thus, the negative association may indicate a trade-off whereby higher production costs limit firms' capacity to sustain investment in innovation.

Labour cost (Lcost) has a negative and statistically significant effect on R&D intensity. This result indicates that rising labour expenditure can restrict firms' capacity to allocate resources toward research and development. When labour expenses increase, a larger share of revenues may be absorbed by production costs, leaving fewer resources for innovation activities that generate returns. This situation may matter for firms experiencing financial constraints. Thus, the negative association may indicate a trade-off whereby higher production costs limit firms' capacity to sustain investment in innovation. Finally, foreign ownership (Fown) has a negative coefficient, but its effect on R&D intensity is statistically insignificant. This finding indicates that foreign ownership does not have a direct influence on R&D activities within the sample. One possible explanation is that multinational firms may locate their R&D functions in their home countries or other locations with stronger research infrastructure. Consequently, foreign subsidiaries in Indonesia may concentrate mainly on production, assembly, technology adoption, or other operational activities, while relying on technologies developed elsewhere rather than conducting substantial R&D domestically.

Overall, the IV-2SLS estimation results suggest that profitability and firm characteristics are more important in explaining R&D intensity than industrial concentration. While market concentration does not show a statistically significant direct effect on R&D, a higher PCM significantly increases firms' incentives and capacity to invest in innovation. These findings imply that policies aimed at promoting innovation should not focus solely on changing market structure or increasing market concentration. Instead, policies should also strengthen firms' financial capacity, improve access to innovation financing, and support the development of firm-level capabilities required for R&D activities.

4.7. Industri Concentration and R&D

Industry concentration (CR4) in [Table 8](#) has a coefficient value of -2.110, but its probability value is greater than five percent, meaning that the level of industry concentration (CR4) does not have a significant effect on R&D expenditure in this model. Therefore, the research hypothesis (H1), which states that industry concentration influences R&D, is rejected. Companies' decisions to conduct R&D are not always determined by market structure; they are also influenced by other factors, such as internal company factors, industry characteristics, and consumer demand dynamics. In consumer-driven industries based on incremental innovation, such as food and beverages, the effect of market concentration on R&D is weak or even statistically insignificant. Previous findings from [Setiawan et al \(2021\)](#); [Bajgar et al \(2023\)](#); [Covarrubias et al \(2020\)](#) and [Widodo et al \(2015\)](#) found a positive effect of industry concentration on corporate R&D.

However, this finding is supported by research by [Coad et al \(2021\)](#), which found that R&D investment is more influenced by a company's internal characteristics than by market structure. This means that even if an industry is concentrated, companies within it will not necessarily increase R&D if they lack a strong innovation strategy. Furthermore, it is possible that large companies in concentrated industries experience innovation inertia. This means that once companies are dominant, they lack a strong incentive to increase R&D because they already enjoy a stable market share. This phenomenon is also discussed in modern literature, such as [Akcigit & Ates \(2021\)](#), which shows that increased concentration in some cases actually correlates with decreased innovation dynamics.

4.8. Price Cost Margin and R&D

The Price Cost Margin (PCM) coefficient in Table 8 is 0.223 and has a significance level of one percent. This means that a one percent increase in PCM will increase R&D expenditure by approximately 0.223 percent, assuming all other variables remain constant (*ceteris paribus*). Therefore, the research hypothesis (H1), which states that PCM influences R&D expenditure, cannot be rejected. A company's profitability has a positive and significant impact on R&D expenditure. Companies with higher profits have more adequate financial resources to fund R&D activities. Profitability is a strategy for each company to boost competitiveness and maintain its market position (Mayuni et al., 2024; Kruglov & Shaw, 2024; Judijanto, 2024). Theoretically, this finding is supported by endogenous growth theory, which states that investment in research and development is a key driver of innovation, increased productivity, and economic growth. In other words, companies with greater financial capacity tend to increase R&D investment to create new technologies and improve production efficiency (Judijanto, 2024).

Although these results indicate that PCM influences corporate R&D, previous research has found a negative impact of PCM on R&D. For example, research by Sari & Putikadea (2025) showed that innovation investment does not always immediately improve company performance because R&D results usually take time to generate financial returns. Furthermore, Yang et al (2010) found a nonlinear correlation between R&D and profitability, where early R&D investment can actually reduce profitability due to high research costs before the benefits of innovation are realized. Conversely, this study is supported by findings from previous studies from Setiawan et al (2021), Singh (2022), Shukla (2022), Ridhwan et al (2025), Judijanto (2024), Mayuni et al (2024) and Kruglov & Shaw (2024), which found that PCM has a positive effect on a company's research and development (R&D) expenditures. Thus, this finding reinforces the view that a company's profitability is a crucial factor in increasing investment in R&D. Higher company profitability will generally support innovation activities to maintain the company's competitiveness in a competitive market.

4.9. Company Size and R&D

Company size (Csize) in Table 8 has a coefficient value of 0.907 and a significance level of 1 percent for R&D expenditure. This means that a one percent increase in Company size leads to a 0.907 percent increase in R&D expenditure. Therefore, the research hypothesis (H3) that Company size influences R&D expenditure cannot be rejected. In the context of the Indonesian food and beverage industry, this finding demonstrates the highly competitive nature of the industry and the need for continuous product innovation. Larger firms naturally have a higher production scale, substantial capital, advanced technology, and qualified human resources, enabling them to invest in innovation (Yuliyanti, 2024; Oruganti et al., 2024).

In the context of the Indonesian food and beverage industry, this finding demonstrates the highly competitive nature of the industry and the need for continuous product innovation. Larger firms naturally have a higher production scale, substantial capital, advanced technology, and qualified human resources, enabling them to invest in innovation (Yuliyanti, 2024; Oruganti et al., 2024). Conversely, this finding is supported by previous research from Yiu et al (2020), Chen et al (2023), Santos et al (2024), Saharti (2025) and Hutaauruk (2024), which found that company size has a positive effect on innovation. Overall, these research findings reinforce the view that larger companies have the ability to invest in innovation, thereby increasing product innovation and maintaining a competitive advantage in the market.

4.10. Labor Costs and R&D

Labor costs (Lcost) in Table 8 have a coefficient value of -1.133 and a significance level of one percent, indicating that a one percent increase in labor costs can reduce R&D expenditure by -1.133 percent, assuming other variables remain constant. Therefore, the research hypothesis (H4), which states that labor costs have an impact on R&D expenditure, is rejected. This finding suggests that companies tend to allocate resources to key operational costs, particularly labor, thereby reducing their ability to invest in R&D activities. This phenomenon can be understood in the context of the structure of the Indonesian food and beverage industry. This industry's activity during the 2015-2019 period showed an above-average increase of 8.16 percent (Ministry of Industry, 2021), but the level of innovation activity and R&D investment remains relatively low compared to the high-tech sector. In fact, R&D expenditure is generally less than one percent of total industrial output, thus limiting innovation in this sector (Setiawan et al., 2022).

This finding supports the budget constraint theory, which states that companies have limited financial resources and must prioritize the allocation of funds between operational costs and

innovation investment (Kuga, 1996). However, this finding differs from previous studies from Deng et al (2022), Moretti et al (2021) and You et al (2023), which found that rising labor costs can increase corporate R&D investment, as companies are encouraged to replace labor with technology and innovation. Furthermore, high Lcost pressures encourage investment and increase corporate R&D expenditures. Furthermore, rising labor Lcosts encourage companies to increase investment in R&D in an effort to replace labor input with new, more efficient technologies. Conversely, this finding is supported by previous studies Onyekwere (2019), Južnik (2022) and Ding et al (2025), which found that labor costs have a negative impact on R&D. Overall, increasing labor costs can be a factor that limits company investment in research and development activities, so companies need to maintain cost efficiency and increase profitability to continue to be able to invest in innovation to increase long-term competitiveness.

4.11. Number of Employes and R&D

The coefficient value for the total workforce in Table 8 is 0.813, indicating that the workforce has a positive and significant effect of one percent on R&D. This finding indicates that when the workforce increases by one percent, R&D increases by 0.813 percent. This means that the larger the workforce, the more likely the company is to engage in R&D activities. Therefore, the research hypothesis (H5) that states that the total workforce can increase the company's R&D expenditures cannot be rejected. Companies with a larger workforce have a greater opportunity to form research teams, develop new products, and improve the quality of production processes. According to Joseph Schumpeter's innovation theory, companies with more resources certainly have the opportunity to innovate because they have sufficient organizational capabilities, capital, and workforce to experiment with new technologies and products. Innovation through R&D is considered a way for companies to gain a competitive advantage and product differentiation in the market (Fayyaz & Bartha, 2025). However, this finding is inconsistent with previous research from Vota (2022) and Maskudi et al (2024), which found that the total workforce negatively impacts a company's innovation activities. This is because Nworkee innovation is more influenced by organizational behavioral factors such as knowledge sharing, psychological contracts, and Nworkee engagement, rather than solely by the number of workers.

Conversely, this finding is supported by previous research from Huong & Thanh (2024), Hang et al (2024) and Sime & Tadesse (2025), which found that the total workforce positively impacts R&D. According to theory and previous research, it can be concluded that a company's total workforce can increase R&D activities by increasing the capacity of human resources involved in the innovation process. However, this influence also depends on how the company manages its workforce, including skills development, knowledge sharing, and Nworkee involvement in the innovation process.

4.12. Foreign Ownership and R&D

Foreign ownership (Fown) in Table 8 does not have a significant effect on a company's R&D expenditure (Ln_rd), as its probability value is higher than five percent. Therefore, the research hypothesis (H6), which states that foreign ownership can increase R&D expenditure, is rejected. This finding indicates that companies with foreign ownership do not always increase innovation activities or R&D expenditure in local companies. In many cases, multinational corporations with subsidiaries in developing countries tend to concentrate R&D activities in their home countries or global research centers, resulting in the host country branch acting more as a production or marketing unit than an innovation center (Belderbos et al., 2014). Furthermore, R&D investment decisions in companies within multinational groups are often centrally determined by the parent company, so the level of R&D in subsidiaries does not entirely depend on the ownership structure in the host country (Kwon & Park, 2018).

This finding indicates that companies with foreign ownership do not always increase innovation activities or R&D expenditure in local companies. In many cases, multinational corporations with subsidiaries in developing countries tend to concentrate R&D activities in their home countries or global research centers, resulting in the host country branch acting more as a production or marketing unit than an innovation center (Belderbos et al., 2014). Furthermore, R&D investment decisions in companies within multinational groups are often centrally determined by the parent company, so the level of R&D in subsidiaries does not entirely depend on the ownership structure in the host country (Kwon & Park, 2018). However, this finding differs from previous research that suggests foreign ownership influences innovation. For example, Wu et al (2024) found that foreign ownership has a positive and significant effect on corporate innovation, particularly when the company receives

government innovation subsidy support. Furthermore, [Nguyen-Van & Chang \(2019\)](#) also found that foreign ownership can enhance innovation when the company has adequate R&D capacity. R&D acts as an absorptive capacity, enabling companies to more effectively utilize technology brought by foreign investors. Conversely, this finding supports previous research from [Kwon & Park \(2018\)](#), [Setiawan et al \(2021\)](#) and [Roedder & Schmid \(2025\)](#), which suggests that foreign ownership does not always drive increased R&D activity in the host country, as research is often centralized in the home country, which is the company's primary operating center. Therefore, the lack of foreign ownership in this study is consistent with some previous literature, particularly that research activity in multinational companies is often centralized in the parent company, thus not always increasing R&D expenditures in subsidiaries in the host country.

4. Conclusion

R&D spending in Indonesia's manufacturing sector, especially within the food and beverage industry, is largely determined by firm-level conditions, such as profitability (PCM), production capacity or firm size, and workforce size. In contrast, labor expenses and foreign ownership are associated with lower R&D spending. Industrial concentration, represented by CR4, does not appear to exert a significant influence on R&D expenditures. This research extends broader literature in several respects. First, it presents empirical evidence concerning the factors associated with R&D spending in Indonesian manufacturing, with particular attention to the food and beverage industry, an area that has received limited attention in studies of innovation within developing economies. Second, the analysis considers firm characteristics and industrial market structure concurrently to identify their respective roles in determining R&D spending. The results indicate that firm-level characteristics are more influential than industrial concentration in explaining R&D expenditures. Accordingly, the study adds to the continuing discussion of how market structure shapes innovation by presenting evidence from Indonesia's manufacturing sector. Third, the study provides sector-specific findings that can support policymakers and industry stakeholders in developing measures to stimulate R&D investment and strengthen innovation.

Furthermore, these findings indicate the importance of the government creating a healthy competitive climate and encouraging innovation. Fiscal policies, such as tax incentives and super tax deduction schemes, need to be strengthened to increase R&D investment. In addition, improving human resource quality through training and increasing labor productivity are crucial to mitigate the negative impact of labor costs on R&D expenditures. The government also needs to encourage collaboration between industry and universities and provide joint research facilities to strengthen innovation capabilities. This study has several limitations. First, the relatively short observation period, covering only 2017 to 2019, prevents the study from capturing long-term dynamics. Second, data limitations restrict the exploration of other variables that may influence R&D expenditures. Therefore, future research is recommended to use a longer observation period and consider more robust estimation methods, such as dynamic panel models or models that explicitly address endogeneity. Furthermore, the inclusion of variables such as technology intensity, product innovation, and institutional factors is expected to provide a more comprehensive understanding of the determinants of R&D expenditures.

Acknowledgment

The authors extend our deepest appreciation to Airlangga University, particularly the Faculty of Economics and Business, for their full support, providing facilities such as access to international journals, which enabled this research to be completed. We also extend our deepest appreciation to our colleagues and reviewers for their criticism and input, which enabled us to improve the shortcomings of this article.

Declarations

- Author contribution** : Each author made equal contributions to the primary content of this paper. Furthermore, all authors have carefully reviewed and endorsed the final manuscript
- Funding statement** : No funding statement for this paper.
- Conflict of interest** : The authors declare no conflict of interest.
- Additional information** : No additional information is available for this paper.

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