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Article

R&D and Industrial Concentration in the Indonesian Manufacturing Industry

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Abstract: This research investigates the relation between research and development (R&D) expenditure and the industrial concentration in the Indonesian manufacturing industry. Pooled least square dummy variable is applied to estimate the relation between the two variables. This research uses firm-level data taken from the survey of the manufacturing industry sourced from the Indonesian Bureau of Central Statistics. This research makes contributions in calculating the percentage of R&D expenditure using the recent data and freshly estimating the relation between R&D and industrial concentration in the industry. This research finds that the percentage of R&D expenditure is relatively low in the industry. There is also a declining trend in the percentage of the R&D expenditure from the period 1994–1995 to 2017. The higher industrial concentration increases the percentage of R&D expenditure. This research also finds that R&D expenditure can be higher in the firms with market power.

Keywords: R&D expenditure; industrial concentration; price-cost margin; Indonesian manufacturing industry



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1. Introduction

Research and development (R&D) has been well known as one of the sources of firm competitiveness. In the literature of industrial organization, the R&D is commonly connected to industrial concentration. Empirical studies about the relation between R&D and industrial concentration have been frequently investigated, but the results still varied and there was still a need for more cases to be investigated using different data and approaches.

The Indonesian manufacturing industry is a nice case to investigate to learn more about the relation between R&D and industrial concentration. The industry makes a significant contribution to the Indonesia economy. BPS [1] reported that the industry contributed about 19% to the gross domestic product in 2017. Also, it absorbed about 15% of the total employment in Indonesia in 2017. The Indonesian ministry of industry also had already made a roadmap to develop the manufacturing industry into industry 4.0 which may need more investment in R&D. Despite the importance of the industry, the industry has a high industrial concentration [2]. Setiawan & Effendi [2], Setiawan et al. [3–6], Setiawan [7,8] and Setiawan and Sule [9] found that the high industrial concentration causes welfare losses, increasing inefficiency in the industry. Moreover, Setiawan & Oude Lansink [6] found that there was a dynamic technical regress in the Indonesian food industry which had high industrial concentration. The research might have an indication that the high industrial concentration may also limit R&D development and innovation of the firms in Indonesian manufacturing sector. Internal and external knowledge from open innovation may not be significantly considered by the firms operating in the highly concentrated industry. Furthermore, the limitation in innovation and R&D activity may also lower the

performance of the firms and industry [10]. Thus, the research investigating the relation between industrial concentration and firm's R&D is important.

Previous research investigating the relation between R&D and industrial concentration was not conclusive. For example, Vossen [11] and Artés [12] found that there was a positive association between R&D and industrial concentration. On the contrary, Voinea [13] found that the higher R&D of the firms might exist in lower industrial concentration. Also, Lee and Hwang [14] found that the industrial concentration did not have a significant effect on the R&D. Silva et al. [15] found that the effect of market concentration on the R&D can be different between products. Regarding that, this research can make a contribution by providing insights to the literature on the relation between R&D and industrial concentration.

Regarding the relation between industrial concentration and R&D, there is hardly any empirical research investigating the relation between the firm's R&D expenditure and industrial concentration in the Indonesian economy. For example, Setiawan et al. [5,16], Setiawan and Effendi [2], Setiawan and Oude Lansink [6], and Setiawan [7] only investigated the relation between industrial concentration, price cost margin, and technical efficiency in the Indonesian manufacturing sector. Moreover, Mulyanto [17] investigated only the R&D productivity and its determinants in the Indonesian R&D institution, not including the R&D activities in the manufacturing industry. Also, Yang and Chen [18] investigated only the relation among the variables of R&D, productivity, and export in the Indonesian manufacturing sector. Therefore, research investigating the relation between industrial concentration and R&D in the Indonesian manufacturing is still relevant.

Research investigating the relation between R&D and industrial concentration was mostly applied at the industry level (see [19–21]). An investigation on the effect of the industrial concentration on the R&D at the firm level was done by Artés [12]. Investigating such relationships using firm level data is important, since the effect of the industrial concentration is directly connected to the firm's decision on R&D investment. The firm's decision on the R&D expenditure may not be fully seen if the investigation is conducted at the industry level.

The purpose of this research is to investigate empirically the relation between R&D and industrial concentration in the Indonesian manufacturing industry at the firm level. This research will also have policy implications regarding the firm's R&D behavior in facing the market structures. The industry can be limited to grow in its concentration if the concentration constrains the firms' R&D. For example, mergers between firms should be evaluated carefully by the Indonesian competition authority if the merger increases industrial concentration and limits R&D and innovation.

The paper is organized as follows. Section 2 provides a literature review. Section 3 describes the research methods. This is followed by the description of data in Section 4 and the presentation of the empirical model and results in Section 5. The Section 6 provides a discussion and the last section summarizes the results and draws conclusions.

2. Literature Review

Schumpeterian hypothesis [22] argues that R&D activity is usually conducted by the big firms, since the R&D expenditure is expensive. Thus, the hypothesis may suggest that R&D expenditure can be related to the firms operating in the highly concentrated industry. In line with that, Vossen [11] investigated the effect of the industrial concentration on R&D of small and large firms in the Dutch Manufacturing industry. The research found that the industrial concentration had a positive effect on the rate of R&D expenditure, and the effect does not differ significantly between industries. Moreover, Misra [23] investigated the R&D and its association with industrial concentration using pooled data of 134 industries of the Indian manufacturing sector from 2000 to 2006. The results showed that R&D which aimed to produce product innovation had a strong correlation with market concentration. The company which had a large market share also had high technological competence. Furthermore, Artés [12] investigated the association between the R&D expenditure and

industrial concentration. The research also found that the probability of conducting R&D activities was positively affected by industrial concentration. Also, Silva et al. [15] investigated the relation between R&D intensity and market concentration in the Brazilian seed markets. They found that there was a positive relationship between R&D intensity and industrial concentration in the corn seed market. With respect to a possibility of lower competition caused by the higher industrial competition, the finding from Lee et al. [24] might give an insight that the lower competition could affect the choice of decisions for innovation or R&D across different stages of innovation.

In contrast with Vossen [11], Artes [12], and Misra [23], and Voinea [13] analyzed how market concentration affected the R&D activities of the only foreign-affiliated firms in the manufacturing industries in five European economic transition countries i.e., Romania, Poland, Croatia, Slovenia, and East Germany. This study found that foreign-affiliated firms in more concentrated markets were more integrated in their foreign investor networks. Foreign-affiliated firms in more concentrated markets did more basic and applied research that did not influence product or process innovation. On the other hand, foreign-affiliated firms in less concentrated markets or high competition markets were more motivated to do process innovation, encouraged knowledge creation, acquired more technology from outside their networks, and also increased the diffusion or absorption of the external knowledge. Furthermore, Lee and Hwang [14] investigated the effect of the industrial concentration on the R&D investment in information technology (IT) of the non-IT Korean Manufacturing sector. They found that industrial concentration did not have a significant effect on the R&D investment in IT manufacturing. The later suggested that the R&D activities might be different between sectors. These findings did not support the Schumpeter concept in the relationship between R&D and industrial concentration. Also, Silva et al. [15] found a negative relationship between R&D and industrial concentration in the soybean seed market.

Other determinants may affect the R&D expenditure of the firms in the industry. The R&D can be affected by firm ownership (Fown) [25,26], number of employees (Employ) [27], labor wage (Wage), and firm size (FSize) [12,28,29]. Lee [25] and Kwon and Park [26] found that firm ownership affected the R&D of the firms. Lee [25] found that private-united and public-united firms were likely twice more innovative than sole proprietorship firms. Despite this, they found that there was no evidence of the correlation between R&D expenditure and foreign ownership. Furthermore, Harris & Trainor [27] found that R&D spending-per-unit of sales in the Northern Ireland manufacturing industry was negatively affected by the number of employees. Despite this, the average wage of labor had positive and significant effects on innovation activity persistency [28]. In contrast to Antonelli et al. [28], Özçelik and Taymaz [30] found that in the Turkey manufacturing industry, the price variables such as wage rate were not significant determinants of R&D intensity. Kumar & Saqib [29], Artés [12], and Antonelli et al. [28] also found positive and significant relationships between R&D and firm size. Moreover, Lundin et al. [31] found that price-cost margin could affect the R&D intensity, although the positive and significant effects were only found in high-tech firms. In line with Lundin et al. [31], Misra [23] found that for a given level of market concentration, the industries which earned higher price-cost margin engaged themselves more rigorously in R&D activity than the industries which earned low price-cost margin. Antonelli et al. [28] also suggested that the price-cost margin could affect the R&D intensity positively, although their empirical research suggested a weak effect of price-cost margin on R&D. Although it is not directly connected to R&D, Bhattacharya & Bloch [32] also suggested that the innovation was determined by firm size and profit. Bhattacharya & Bloch [32] found that firm size had positive and significant effects on innovation and R&D, respectively.

Based on the theoretical and empirical background, it is hypothesized that the industrial concentration (IC) can affect the R&D (RD) positively or negatively. Price-cost margin (PCM), firm size, wage, and foreign ownership are also hypothesized to affect positively the R&D. Number of employees is hypothesized to affect the R&D negatively.

3. Methods

Based on the hypotheses in the previous section, the mathematical relationship between the variables can be derived as follows:

$$RD = f(IC, PCM, FSize, Wage, Employ, FOwn) \tag{1}$$

where $\frac{\partial RD}{\partial IC} > 0$ or $\frac{\partial RD}{\partial IC} < 0$, $\frac{\partial RD}{\partial PCM} > 0$, $\frac{\partial RD}{\partial FSize} > 0$, $\frac{\partial RD}{\partial Wage} > 0$, $\frac{\partial RD}{\partial Employ} < 0$; $\frac{\partial RD}{\partial FOwn} > 0$.

This research uses the econometrics method to estimate the relation between industrial concentration and R&D (this method is a common approach in economics and has valid instruments to see the effect of the independent variables on the dependent variables.) Adding subsectors and year dummies (subsectors and years dummies can be included in the model to consider heterogeneity of the R&D among subsectors and years.) in the Equation (1), this research applies an econometrics model, as follows:

$$RD_{it} = \sigma + \alpha_1 IC_{jt} + \alpha_2 PCM_{it} + \alpha_3 FSize_{it} + \alpha_4 Wage_{it} + \alpha_5 Employ_{it} + \alpha_6 Fown_{it} + \alpha_7 D95_{jt} + \alpha_8 D17_{jt} + \sum_{j=1}^m \beta_j IND_j + e_{it} \tag{2}$$

where *i* and *t* indicate the firm and period, respectively; RD is percentage of research and development expenditure (R&D); IC is industrial concentration; PCM is price-cost margin; FSize is firm size, Wage is average cost of labor; Employ is the number of labor; FOwn is the dummy for foreign ownership; D95 and D17 are dummies for the observations in years of 1995 and 2017, respectively; IND is the dummy for each subsector *j*; *e* is an error term that captures statistical noise.

Equation (2) is estimated using a pooled least square dummy variable (LSDV) regression model with subsectors and years dummies. Nevertheless, the subsector dummies and year dummies which can represent fixed effects in the model will be tested using a Wald test to determine whether the variables contribute to the correct model specification. The model is estimated using both measures of CR4 and HHI. The model will also be corrected using White-Heteroscedasticity Consistent Covariance if the model suffers from the heteroscedasticity problem.

The R&D variable is represented by the percentage of R&D expenditures relative to the output of the firm. The percentage of R&D expenditure as a measure of R&D activities is also used in several previous R&D studies, such as research by Alexander et al. [33]; Harris and Trainor [27]; Vossen [11]; Lundin et al. [31]; and Voinea [13].

This research uses a concentration ratio of 4 (four) firms (CR₄) and Herfindahl-Hirschman Index (HHI) to measure the industrial concentration. CR₄ is defined as the collective share of the four biggest firms in a subsector, while HHI describes the uneven distribution of market shares for the whole firm in a subsector. Thus, both measures of industrial concentration complement each other. Both indicators of industrial concentration are based on the market share of the firms and calculated by the formulas as in Setiawan et al. [2–8]. CR₄ and HHI are calculated by the formulas:

$$CR_4 = \sum_{i=1}^4 SM_{ij} \tag{3}$$

$$HHI = \sum_{i=1}^n (SM_{ij})^2 \tag{4}$$

where SM_{ij} defines the market share or share of sales of firm *i* in each subsector *j*.

Price-cost margin represents the ability of the firm to set the price over production cost in an industry. In this research, PCM is calculated according to the formula used by Domowitz, Hubbard, & Petersen [34], Prince & Thurik [35], Setiawan et al. [3–6], and Setiawan [7,8] which is formulated as follows:

$$PCM_{ij} = \frac{\text{Value Added}_{ij} - \text{Cost of Labor}_{ij} + \Delta \text{Inventories}_{ij}}{\text{Sales}_{ij} + \Delta \text{Inventories}_{ij}} \tag{5}$$

where value added is calculated by total sales minus intermediate inputs except labor cost, cost of labor is total wages, sales are total sales (output) value, Δ Inventories is the change in stock of output from the beginning to the end of the year [5].

As defined by Setiawan et al. [4,5], Indiastuti and Setiawan [36], Effendi et al. [37], and Setiawan and Sule [9], the wage is calculated by dividing the total cost of labor with the number of employments in each firm. Employ is calculated as the number of workers at the firm level. Firm size (FSize) is measured by the natural logarithm of firm output. Since the industrial concentration and price-cost margin are endogenous, this research applies instrumental variables. The instrumental variables for industrial concentration include market growth (Mgrowth), average capital output ratio (Acor), market size (Size), and year dummies [5–8]. The instrumental variables for the price cost margin include dummy of government ownership (DGovt), capital-output ratio (COR), and year dummies [5,8]. As also applied by Setiawan et al. [3–5], Mgrowth is measured by output growth which can be calculated from the subsector's output growth rate in the industry. COR is the ratio between the value of capital and the output value of a firm in the subsector. Capital and output are measured with the value of fixed assets and the value of output produced, respectively. Capital and output are deflated by the consumer price index as applied by Setiawan et al. [6]. Both are calculated at the firm level (i), then averaged at the subsector level (j) in the industry. MSize is measured by the natural logarithm of the subsector's output in the industry.

4. Data

This research uses firm level data from the industrial manufacturing survey sourced from the Indonesian Bureau of Central Statistics. This research uses 420 subsectors of the International Standard Industrial Classification (ISIC) Level (Actual codes used comes from Klasifikasi Baku Lapangan Usaha Indonesia (KBLI), which are comparable with the ISIC codes.) in the Indonesian manufacturing industry. This research only uses the periods of 1994–1995 and 2017, since the variable of research and development (R&D) is not surveyed annually. Actually, the R&D expenditure was also surveyed in the period 1999–2000. (This research did not include the period 1999–2000 in the analysis, since the pre-analysis found that there was a perfect multicollinearity problem in the model when including those periods. In spite of this, the average percentage of R&D was also low and it had a declining trend in those periods.) This paper includes all firms in the subsectors having less than four firms in each period, since this research assumes that R&D activities will be conducted by the subsectors with tight oligopoly structure or close to monopoly.

Table 1 shows that only the variables of HHI, R&D, market growth, and average capital output ratio (COR) were relatively heterogeneous by having a standard deviation of more than the mean of the variables. The data also reported that there were about 11.73% of the firms having a significant share of the foreign firms. From Table 1, it is seen that the percentage of R&D expenditure in the Indonesian manufacturing sector was relatively low with an average of 0.032% during the three-year period (1994–1995 and 2017). The percentage of R&D expenditure also had a declining trend during the period 1994–2017. For example, the percentages of R&D expenditure were 0.043, 0.037, and 0.018 during the years of 1994, 1995, and 2017, respectively. This indicated that the innovation in the manufacturing industry might not improve over time. This also may cause the technical progress to not develop in the industry. The data supported the finding from APO [38], Setiawan and Oude Lansink [6], and Setiawan [8] who found that the manufacturing industry had technical regress.

Table 1. Descriptive statistics of the variables.

| Variable | Mean | Standard Deviation | Minimum | Maximum |
|----------------------------|--------|--------------------|------------------------|---------|
| CR4 | 0.494 | 0.239 | 0.066 | 1.000 |
| HHI | 1426 | 1648 | 34.857 | 10,000 |
| R&D (%) | 0.032 | 0.402 | 0.000 | 49.193 |
| PCM | 0.477 | 0.238 | −1.153 | 0.999 |
| Firm Size | 14.879 | 2.584 | 7.279 | 25.424 |
| Market Size | 21.701 | 2.236 | 10.086 | 26.851 |
| Market Growth (%) | 0.011 | 0.385 | 8.980×10^{-4} | 1.000 |
| Average COR | 3.433 | 8.447 | 0.010 | 381.369 |
| N-firms | 63,238 | 63,238 | 63,238 | 63,238 |
| % Firms with foreign share | 11.73% | | | |
| R&D (%) | | | | |
| Year 1994 | 0.043 | | | |
| Year 1995 | 0.037 | | | |
| Year 2017 | 0.018 | | | |

Source: authors' calculation.

5. Results

Table 2 shows the twenty subsectors with highest percentage R&D expenditure during the period 1994–1995 and 2017. A subsector of other communication equipments had the highest percentage of R&D expenditure of 0.499%. Furthermore, almost all the subsectors included in the twenty subsectors with the highest percentage R&D expenditure could be classified as tight oligopoly structures (the HHI is transformed into interval of 0–1). Only subsectors of pharmacy products grouped into twenty subsectors with the highest percentage R&D expenditure had low industrial concentration. Besides the declining trend of the percentage of R&D expenditure, the percentage of R&D expenditure was relatively low for each subsector. This indicates that R&D activities in Indonesian manufacturing industry did not develop during the period 1994–1995, 2017.

Table 3 shows the results of the estimation of Equation (2), which is estimated using a pooled regression model with fixed effects using only year dummies. The Wald test did not reject the null hypothesis of specification error for including the variables of subsectors dummies at the 10% critical level (The Wald test is simply a test of significance of all subsectors dummies simultaneously in affecting the R&D in the model.) Furthermore, including subsector dummies into the model also caused biases in the relationship between R&D and other independent variables. Therefore, the final model estimation did not include the subsector dummies. The White test for heteroscedasticity rejected the null hypothesis of the absence of heteroscedasticity at the 5% critical level. To address the problem of heteroscedasticity, this paper applied the White-Heteroscedasticity Consistent Covariance method to correct the inefficiency of the standard error in the model estimation. The *p*-value of the Hansen-J statistics also confirmed that all instrumental variables applied for the endogenous variables of PCM and HHI were valid at the 10% critical level.

Table 2. 20 (Twenty) Subsectors with Highest Percentage R&D Expenditures (%), 1994–1995, 2017.

| No. | ISIC | Industry | R&D (%) | CR4 | HHI |
|-----|-------|--|---------|-------|-------|
| 1 | 26399 | Other communication equipments | 0.499 | 0.972 | 0.318 |
| 2 | 23112 | Safety glass | 0.461 | 1.000 | 0.534 |
| 3 | 28250 | Machinery, food, drink, tobacco processing | 0.429 | 0.970 | 0.545 |
| 4 | 10412 | Margarine | 0.365 | 1.000 | 0.924 |
| 5 | 28112 | Combustion | 0.354 | 1.000 | 0.638 |
| 6 | 10762 | Processed herb | 0.348 | 0.847 | 0.240 |
| 7 | 11020 | Wines | 0.334 | 1.000 | 0.614 |
| 8 | 28120 | Liquid & gas-powered equipment | 0.309 | 0.957 | 0.353 |
| 9 | 20113 | Inorganic pigments | 0.294 | 0.990 | 0.467 |
| 10 | 21021 | Simplicia | 0.278 | 0.990 | 0.549 |
| 11 | 20294 | Essential oils | 0.265 | 0.729 | 0.166 |
| 12 | 21012 | Pharmacy product | 0.244 | 0.317 | 0.041 |
| 13 | 10779 | Other food products nec | 0.236 | 0.911 | 0.441 |
| 14 | 26513 | Electronic measuring equipment | 0.234 | 1.000 | 1.000 |
| 15 | 10298 | Pulverized other aquatic biotas | 0.218 | 0.946 | 0.391 |
| 16 | 18112 | Value publishing | 0.176 | 0.713 | 0.150 |
| 17 | 20111 | Basic inorganic | 0.175 | 0.918 | 0.726 |
| 18 | 10313 | Dried fruit, vegetable | 0.172 | 1.000 | 0.910 |
| 19 | 10299 | Other processes of other aquatic biotas | 0.168 | 0.718 | 0.197 |
| 20 | 11090 | Other beverages | 0.163 | 0.929 | 0.445 |

Source: authors' calculation.

The results in Table 3 suggest that industrial concentration had a significant effect on the research and development of the firms, both for the CR4 and HHI measures. As hypothesized, a higher industrial concentration might yield a higher R&D for the firms. The CR4 coefficient of 0.068 indicates that the R&D increased by 0.068% following a 1-unit rise in CR4, *ceteris paribus*. Additionally, the HHI coefficient of 0.141 shows that the R&D increased by 0.141% for every 1-unit increase in HHI, *ceteris paribus*. Therefore, the results show that R&D of the firms in the Indonesian manufacturing industry benefit from highly concentrated industry. This result is also supported by the data where, on average, R&D is higher in most of the subsectors with highly concentrated industry (see Table 1). The results presented here supported the hypothesis and findings of other studies, such as [11,12,23] which found a positive impact of industrial concentration on the R&D.

Price-cost margin had a positive effect on the R&D with the coefficients of 0.489 and 0.458 for the models using CR4 and HHI measures, respectively. The coefficients were significant at the 10% critical level. The coefficients of 0.489 and 0.458 indicated that every 1-unit increase in the PCM increased R&D by 0.489% and 0.458% for the models with CR4 and HHI, respectively. The result supported the hypothesis of the positive effect of the PCM on the R&D. This finding also supports the research of Lundin et al. [31], Misra [23], and Antonelli et al. [28] who found the positive effect of the PCM on the R&D.

Table 3. Regression of industrial concentration and other variables on the R&D.

| Independent Variable | Dependent Variable: R&D | |
|-------------------------------|--|--|
| | Coefficients | Coefficients |
| Intercept | −0.450 ** (0.218) | −0.408 *** (0.207) |
| CR4 | 0.068 *** (0.025) | |
| HHI | | 0.141 *** (0.052) |
| PCM | 0.489 ** (0.250) | 0.458 * (0.243) |
| FSize | 0.019 ** (0.008) | 0.018 ** (0.008) |
| FOwn | 2.22×10^{-4} (2.07×10^{-4}) | 2.22×10^{-4} (2.07×10^{-4}) |
| Wage | 4.16×10^{-4} (5.39×10^{-4}) | 4.36×10^{-4} (5.39×10^{-4}) |
| Employ | 1.95×10^{-6} (8.13×10^{-6}) | 2.61×10^{-6} (8.13×10^{-6}) |
| Year 1995 | −0.007 * (0.004) | −0.008 * (0.004) |
| Year 2017 | −0.139 *** (0.051) | −0.132 *** (0.051) |
| Wald-Statistics | 165.01 | 166.12 |
| p-value Hansen’s J Statistics | 0.100 | 0.100 |

Notes: Values of SE are given within parentheses. * denotes statistically significant at the 10% level. ** denotes statistically significant at the 5% level. *** denotes statistically significant at the 1% level.

Firm size (FSize) had positive and significant effects on the R&D with the coefficients of 0.019 and 0.018 for the models with CR4 and HHI with a 5% critical level, respectively. The coefficients of 0.019 and 0.018 indicated that every 1% increase in firm size increased R&D by 0.019% and 0.018% for the respective models with CR4 and HHI, ceteris paribus. The positive effect of the firm size on the R&D fit with hypothesis of this research. The result was also in line with the findings from Artés [12] and Antonelli et al. [28] who also found a positive relationship between the two variables.

Moreover, foreign ownership did not have a significant effect on the R&D at the 10% critical level. This did not support the hypothesis of this research. Despite this, the result was supported by Lee [25] and Kwon and Park [26] who also found an insignificant correlation between foreign ownership with R&D and innovation. This might be an indication that the firms with foreign ownership mostly did not have R&D activities in Indonesia, since the R&D activity was mostly conducted at the main office abroad.

Also, this research found insignificant effects of wage and labor on the R&D. The results also did not support the hypothesis of this research. These results did not support the findings from Harris and Trainor [27], Artés [12], and Antonelli et al. [28], but were in line with the research result of Özçelik and Taymaz [30]. The results might be an indication that there was no substitution or complement between R&D and wage and between R&D and amount of labor employed in the Indonesian manufacturing industry.

The dummies of year 1995 and year 2017 had negative coefficients for both models with CR4 and HHI measures. The coefficients of the 1995 dummy were −0.007 and −0.008 for both models with CR4 and HHI and those were significant at the 10% critical level, respectively. The coefficients indicated that the R&D in the year of 1995 was lower than the R&D in the year 1994 by −0.007% and −0.008% for both models with CR4 and HHI, respectively. The coefficients of year 2017 were −0.139 and −0.132 for both models with CR4 and HHI and those were significant at the 5% critical level, respectively. The coefficients indicated that the R&D in the year of 2017 was lower than the R&D in the year 1994 by −0.139% and −0.132% for both models with CR4 and HHI, respectively.

(This could overestimate the mean of R&D variables, since the estimation also consider the covariance between the variables in the model). These indicated that the R&D in the Indonesian manufacturing sector was declining during the period 1994–2017.

6. Discussion

By improving the R&D and innovation, the Indonesian economy will be expected to grow much faster as predicted by endogenous growth theory. The World Bank released data in 2018 which reported that Indonesian R&D was still low, reaching only 0.23% of the GDP or below the average R&D of 0.6% of the GDP in the low-middle income countries. The low percentage of R&D expenditure to the GDP was also consistent with the low percentage of R&D expenditure to the output in the Indonesian manufacturing industry.

This research found that R&D activity will be likely conducted at the highly concentrated industry. This might support the Schumpeterian hypothesis and previous literatures by Vossen [11], Artés [12], and Misra [23] which found that there was a positive relationship between industrial concentration and the R&D. This research may suggest that there is a benefit gained from highly concentrated industry by having a higher R&D. This may indicate that, since R&D is expensive, only the big firms can expend their budget for R&D. Furthermore, the firms with market power may have more possibility to conduct R&D in order to maintain their dominant position in the market, as also found by Lundin et al. [31], Misra [23], and Antonelli et al. [28]. Firms with market power may allocate a part of their super normal profit to finance R&D activities. R&D activities with internal sources of financing will be more efficient than external sources [11,39].

Despite the positive relationship between industrial concentration and R&D, the percentage of R&D expenditure was relatively low with a declining trend in the industry. Thus, the positive impact of the industrial concentration on R&D may not be a justification for the Indonesian competition authority to allow the industry to be highly concentrated. Instead of allowing the industry to be highly concentrated, the Indonesian competition authority may encourage the government to support R&D in Indonesia by giving incentives to firms to conduct R&D activity. The incentives to conduct R&D may also increase the competition between firms in the market, since more firms will create more innovation in their process and product.

Regarding the incentives to conduct R&D activity by the firms, the Indonesian Government actually has established an incentive using Government Regulation (PP) No. 45 Year 1999 which can give companies a reduction in their income tax up to 300% if the company conducted R&D activities. This super deduction tax is also implemented using the regulation from the Ministry of Finance (PMK) with PMK-153/PMK.010/2020. Those regulations are expected to increase the R&D level in Indonesian manufacturing. Also, it is expected that the R&D level is not only conducted by the big firms or highly concentrated industry, but also by the non-big firms or non-highly concentrated industry.

By having incentives, it is expected that the R&D expenditure in Indonesian manufacturing will increase. The increase of the R&D expenditure is assumed to increase the open innovation dynamically, since there is a challenge for the Indonesian firms to bring new ideas to improve the process and the products of the firms. Firms can absorb ideas from internal and external organization to develop the new process or product innovation [40]. The incentive is expected to distribute the knowledge and innovation within and across firms in the industry. Partnership between industry and university can also strengthen the R&D and introduction of technologies in the Indonesian manufacturing industry [41]. In an open innovation environment, the source of knowledge for new research can be mostly directed toward a university-company relationship [42].

7. Conclusions

This research freshly investigates the relation between R&D and industrial concentration in the Indonesian manufacturing industry. Using recent data, this research contributes to the literature by giving a new insight regarding the relation between R&D and industrial

concentration in a developing country like Indonesia. This research is also different from previous research by having industrial concentration, price-cost margin, and other comprehensive variables affecting the R&D using firm level data in the Indonesian manufacturing industry. This research has a limitation in the sample period, since this research did not include the period 1999–2000 where the BPS also surveyed the R&D expenditure of the firms. In spite of this, this might not discourage the results of this research because the condition of R&D in the period 1999–2000 was also the same as the condition of R&D in the periods applied in this research.

This research found that R&D was declining in the Indonesian manufacturing sector. Also, there was no subsector with a significant percentage R&D expenditure in the industry. The R&D was positively affected by the industrial concentration and price-cost margin. Although this research found that the R&D can mostly come from highly concentrated industry with market power, this research found that the R&D expenditure was still very low. Thus, the results may not be a justification that the industry should be highly concentrated.

Other findings suggested that R&D expenditure was not affected by the wage and number of employments. Also, this research found that the foreign firms did not contribute significantly to the R&D in Indonesia. Furthermore, firm size could be a support for the firms to conduct R&D, since R&D was expensive, and the results of the R&D should achieve economies of scale. The results can be other specific findings in Indonesia regarding the relationship among the variables.

Instead of allowing the industry to be highly concentrated, this research implies that policy makers may encourage the firms to conduct R&D by providing fiscal incentive for the firms to conduct the R&D. This is because the percentage of R&D in the industry is relatively low and the percentage of R&D was lower than the average percentage of total R&D in Indonesia. The current government regulation about the fiscal incentive for R&D activities should be implemented effectively to attract firms in R&D investment. The fiscal incentives are expected to give a support to conduct R&D not only for the big firms, but also for the medium and small firms. Thus, the increase of the R&D activities is supposed to improve innovation and competition in the industry.

This research may suggest a future investigation about the relation between R&D and industrial concentration that can include the period 1999–2000 with a new model that can eliminate the problem of econometrics that was faced in this research. A fresh investigation about the impact of the fiscal incentives on the R&D activities in Indonesia may also be suggested. Moreover, the investigation can be extended to see the impact of the increase of the R&D on the competition in Indonesian manufacturing. This future research can help the policy maker to design an appropriate fiscal incentive policy to improve R&D, open innovation, and competition in the Indonesian economy.

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