Impact of R&D Investment on Profitability of Firms in Biomedical Industry

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ABSTRACT

The modern technology is developing at a high speed in recent years, therefore, the research and development investment has become an essential factor for firms to attract consumers, gain more market power and increase profits. However, the large amount of investment expenditure may have negative impacts to firms' current profitability, additionally, firms will even face the risks of investment failure. Due to this, this essay would analyse and discuss the relationship between firms' research and development investments and firms' profitability, using data from Chinese A-share-listed firms in the biomedical industry through the regression model, with a time period of 2016-2020 to explore both short-term and long-term effects. Robustness tests are applied to ensure the stability of the results. Moreover, the essay will explore the special patterns of relationship under the normalization of Covid-19 epidemic by comparing regression results in different time periods, therefore provides better suggestions to firms' further developments.

Keywords: *Investments in Research and Development, Biomedical industry, Profitability, Normalization of Covid-19 Epidemic*

1. INTRODUCTION

1.1. Research background

In recent years, the rapid growth of high technology has significantly impacted all industries, and firms' investments have become an important factor in firms' profitability. Therefore, to win a larger market share and more profits, innovations were essential for attracting consumers and achieving technological economies of scale, thus lower long-term costs of production and improving the firm's profitability. However, the effects of research and development (R&D) investments might not show in the short term. Also, the opportunity cost of enormous spending on R&D might cause damage to firms' current profitability. From above, the motivation of this essay is to discuss the actual relationships between a firm's investments in R&D and the firm's profitability in the short term.

What is more, after the Covid-19 Epidemic came in 2020, business patterns of firms were forced to change to survive and continue developing. According to statistics from WHO (World Health Organization), up to the end of March 2022, the global accumulated confirmed Covid cases had reached 500 million. According to statistics from the National Bureau of Statistics of China, the year-on-year growth rate of GDP in the first quarter of 2019 was -6.80%, and the negative GDP growth rates continued for one more quarter. Due to this, as one of the first countries affected by Covid-19, Chinese firms should have demonstrated evident changes in investment patterns. The industry being researched in this essay is the biomedical industry in China, the reason is that the biomedical industry is supposed to be significantly influenced by a severe global epidemic, as a large amount of money might be invested in the vaccine, medicine, and medical apparatus to fight against the virus and maintain people's living standards.

1.2. Literature Review

People generally reckon that R&D investment is positively related to a firm's profitability. There is not much relevant research in China; however, in the existing studies, the conclusions differ from each other to a considerable extent. As an illustration, in the research done by ZhongJie Shao, YuXin Zhu, Wen Xia, and XiaoMing Li (2021) , the authors concluded that there is no clear relationship between a firm's profitability and investments in R&D [1]. In comparison, the research done by Xiaoyan Wang and Yanqing Liang (2019) shows

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that the relationship between two variables depends on firm's stages of growth, using the regression model to demonstrate that there is a significant negative correlation between the two variables at firm's low-growth stage [2]. Also, the research done by Bin Guo (2006) has shown a complete negative relationship [3].

Moreover, the research done by Liming Gong, and Shisong Jiang (2010) suggests that the relationship between two variables shows an inverted U-shaped curve [4], and the essay done by Xuezhi Liu, Xiaohui Wang, Dong Zhang and Jing Huang (2017) has demonstrated a same result [5]. Similarly, the research done by Yuhua Sheng and Lu Lu (2016) demonstrates a relationship of "Inverted N" shape, which means that the relationship between R&D investment and firm's profitability shows a pattern of "fall-rise-fall" [6]. Due to this, we can easily see that the relationship between R&D investment and firm's profitability was not certain, which provides a motivation for this research paper. However, in order to explore the impact of R&D investment on profitability in the long-term, some essays also do research on the time lagging effects of the investment. As an illustration, the essay done by Laixin Liang and Huanfeng Zhang (2005) illustrates that when R&D input and output lag for a certain period, there will be a significant correlation between two variables [7].

In addition, the range of data collection in the existing studies also varies. Some only focus on one enterprise, while others choose data from various industries, and the different range of data also contributed to the various conclusions. For instance, the research paper done by Chunmei Zheng and Dongsheng Wu (2022) focuses on one industry, as it chooses to use data from high-technology industry to find out whether R&D investment will increase firm's market value [8]. In comparison, the essay written by Xiaoyin Zhang and Zhihua Zhang (2022) uses data from A-share-listed Chinese companies in Shanghai and Shenzhen, which is a wider range [9]. Another example of large-scale research is the essay from Peipei Xu (2016), as all Chinese manufacturing listed companies are taken as samples [10].

From above, due to the great differences, this essay is significant for finding a more precise conclusion of this relationship, which would benefit firms' future R&D investment strategies. Also, this essay would give suggestions for more suitable developments to use in recent years, as it would discuss the patterns under the normalization of the Covid Epidemic.

1.3. Research Contents and Framework

This essay would use the multiple regression model to analyse data, conclude and discuss the relationships between firms' investment in R&D and the special patterns that newly appeared during the Covid-19 pandemic. Also, the essay will use different variables to examine the reliability of conclusion gained. The time period from 2016 to 2020, in the Covid-19 pattern analysis the time period would be divided into 2016-2019 and 2020 for comparison. Also, this essay would give suggestions to how much the firm should invest in R&D, and how to achieve further developments under the situation of people gradually adapting living and working with Covid-19 Epidemic.

The first part is the introduction of the research topic, the second part is methodology and data analysis, the third part is results and discussion, the last part is the Conclusion. This research would help firms to determine the quantity of investments in R&D, which allows firms to avoid loss of profits in the short term and achieve further developments in the long term.

2. METHODOLOGY

This research paper uses Stata as systems for analysing data. Excel is used to organize the data and make charts.

Hausman Test is used to determine the best fit model. The essay would analyse relationships between firm's expenditure in R&D investments and its profitability by constructing multiple regression model. The lagged effects of R&D investment would be analysed using lag regression model, followed by Robustness Test is carried out to test the stability and reliability of the results, using two representative categories of biomedical industry. Also, the special patterns of relationship between variables under Covid-19 are found by comparing the regression results of two different time period: 2016-2019 and 2020. This pattern is also tested.

2.1 Data sources

The data sources in this essay include annual reports of companies, the CSMAR Database, and the CCER Database. The two databases are the most comprehensive financial and economic data supply systems in China at present.

Firms in the biomedical industry could be split into these secondary classifications: The pharmaceutical business, Chemical pharmaceutical, Biological products, Traditional Chinese medicine, Medical service, Medical apparatus and instruments. For the secondary classification of the biomedical industry, there are 82 firms in the chemical pharmaceutical category, 56 firms in the traditional Chinese medicine category, 41 firms in the medical apparatus and instruments category, 21 firms in the biological products category, 65 firms in the medical service category, 13 firms in the pharmaceutical business category. The data used in the Stata analysis in total includes 1130 pieces. The figures are shown in the pie chart below.

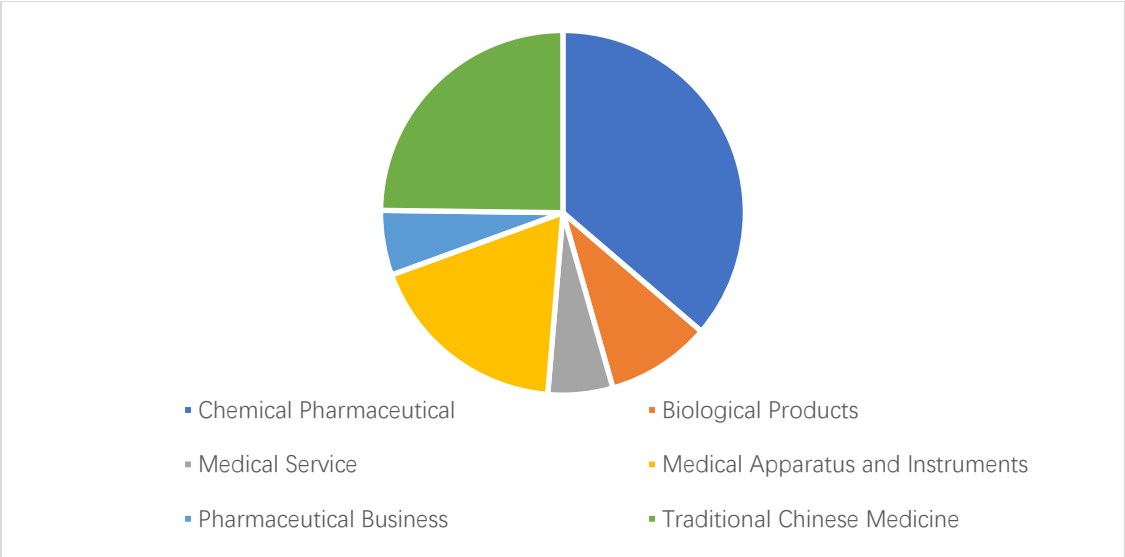

Figure 1 Statistics of Secondary Classification of Biomedical Industry

2.2 Hypothesis

This essay put forward four hypotheses: Firstly, a firm's R&D investment is positively correlated with a firm's profitability. Secondly, the influence of R&D investment on enterprise profitability would be lagged. Thirdly, during the Pandemic, investment was increasing. Lastly, the increase in profitability per unit of R&D expenditure is higher than before the Pandemic.

2.3 Variables and data choice

In this essay, the independent variable is the firm's R&D investment Ratio, calculated by R&D investment/sales. This variable is represented by the abbreviation RDS in the model. The dependent variables are the firm's net interest rates on total assets (Calculated by retained profits/total assets, represented by ROA), the firm's net profit margin on sales (Calculated by net profit/total assets, represented by ROS). The control variables are total assets of the firm (Represented by AST), firm's ratio of expenses to sales (Calculated by selling expenses/operating revenue, represented by MAR), A firm's asset-liability ratio (Calculated by liabilities/assets, represented by LEV).

As a firm's assets, the differences in assets between firms are considerable if using the original number; therefore, to analyze data more intuitively, this essay chooses to calculate the logarithm of the firm's assets. Ln AST represents this new indicator of a firm's asset. In the multiple regression analysis for the relationship between a firm's R&D investment intensity and its profitability, the dependent variable will only be ROA. In the Robustness Test for analysis of unique patterns under Covid-19, ROS would be used as the second variable to examine the stability and reliability of results.

A firm's data will not be used for analysis if : The industry is not the biomedical industry, the firm does not have coherent data from 2016 to 2020, the firm is not a listed Chinese company or the firm does not have R&D personnel. After filtration, the quantity of firms used for data analysis is 258, among 1534 firms in the biomedical industry.

3. MATHS AND EQUATIONS

3.1 Formulas

The formula for analysing lagging effects is:

$$Y_{it} = \mu_i + \alpha X_{it} + \beta_1 AST_{it} + \beta_2 MAR_{it} + \beta_3 LEV_{it} + \varepsilon_{it}$$

In the formula, Y_{it} is the dependent variable, while the is the dependent variable. Letter i represent the sample size while t represents the time period of data collection.

The formula for analysing lagging effects is:

$$Y_{it}=\mu_i+\alpha_0 X_{it}+\alpha_1 X_{i,t-1}+\ldots+\alpha_j X_{i,t-j}+\beta_1 AST_{it}+\beta_2 MAR_{it} +\beta_3 LEV_{it}+\varepsilon_{it}$$

In the formula, $X_{i,t-j}$ represents the value of independent variable after lagging for j phases.

3.2 Hausman Test

In order to determine the best fit model (Random effect model or fixed effect model) for analysis, Hausman Test is applied after defining panel data using order: xtset stkcd (Object of study) year (Time section) receiving the result: Strongly balanced. The stock code of firms are converted into code stkcd for Stata analysis. If coefficient of P-value > 0.01, use random effect model. If coefficient of P-value < 0.01, use fixed effect model.

Table 1. Hausman (1978) specification test

	Coef.
Chi-square test value	48.747
P-value	0

According to the results provided by Stata, coefficient of P-value equals 0, which is less than 0.01. This suggests that we should use the fixed effect model for regression analysis. After confirming to use fixed effect model, datasets are plugged into Stata for analysis.

4. RESULTS

4.1 Descriptive statistics of data

This essay uses Stata to provide descriptive statistics of the variables.

Table 1 provides an overview of each variable used for regression analysis from 1130 observations (226 firms in 5 years), including the following features: Observations, mean, standard deviation, minimum value, and maximum value.

Table 2. Descriptive Statistics of all variables

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	1130	.071	.074	-.298	.744
ROS	1130	.126	.225	-2.676	2.917
AST	1130	7.718e+09	1.220e+10	2.683e+08	1.492e+11
LEV	1130	.33	.175	.014	.99
MAR	1130	.237	.169	.005	1.034
RDS	1130	.056	.057	0	.588
RDA	1130	.026	.023	0	.171

Table 3. Descriptive Statistics of RDS

Variable	Year	Obs	Mean	Std. Dev.	Min	Max
RDS	2016	226	.051	.052	0	.526
	2017	226	.051	.052	0	.499
	2018	226	.056	.058	0	.482
	2019	226	.06	.057	0	.434
	2020	226	.063	.065	0	.588

We could see that the standard deviation of variables is relatively high, which suggests that firms' R&D investments and profitability differ to a large extent. Also, the minimum value after rounding is 0, which means that a firm's R&D investment is only a tiny proportion of its total assets.

Table 2 demonstrates the features of the main independent variable RDS from the year 2016-to 2020. From the Mean column, we can find that the R&D investment intensity increases year by year. (.051 to .063) Due to this, the third hypothesis, that During the Pandemic, investment was increasing, has been confirmed.

4.2 Regression results for the whole biomedical industry

This RDS-ROA regression analysis uses all 1130 data from the datasets and aims to find the general relationship between variables in the whole biomedical industry. After applying the Hausman Test, it has been confirmed that the fixed effect model is more suitable for this analysis.

Table 4. Regression results for the whole biomedical industry

ROA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
RDS	-.405	.062	-6.55	0	-.526	-.284	***
lnAST	.01	.007	1.56	.119	-.003	.023	
LEV	-.032	.025	-1.29	.197	-.08	.017	
MAR	-.025	.026	-0.94	.346	-.076	.027	
Constant	-.117	.143	-0.82	.415	-.398	.164	

Mean dependent var	0.071	SD dependent var	0.074
R-squared	0.054	Number of obs	1130
F-test	12.915	Prob > F	0.000
Akaike crit. (AIC)	-3499.123	Bayesian crit. (BIC)	-3473.973

*** p<.01, ** p<.05, * p<.1

4.3 Lag regression results for one phase

Due to the second hypothesis given in 2.2, the influence of R&D investment on enterprise profitability would be lagged, the essay applies Lag regression model to find the one-phase lag results, which would help to verify our hypothesis.

Table 5. Lag regression results for one phase

ROA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval	Sig
RDS	-.285	.087	-3.29	.001	-.455	-.115	***
RDS1	-.181	.099	-1.83	.067	-.375	.013	*
lnAST	.011	.01	1.20	.231	-.007	.03	
LEV	.002	.036	0.06	.951	-.069	.073	
MAR	-.005	.04	-0.12	.907	-.083	.074	
Constant	-.159	.211	-0.75	.451	-.574	.256	

Mean dependent var	0.070	SD dependent var	0.076
R-squared	0.037	Number of obs	904
F-test	5.168	Prob > F	0.000
Akaike crit. (AIC)	-2773.623	Bayesian crit. (BIC)	-2744.782

*** p<.01, ** p<.05, * p<.1

4.4 Robustness Test for regression results for the whole biomedical industry

For the robustness test of results, this essay chooses two representative secondary categories in the biomedical industry: Chemical Pharmaceutical and Traditional Chinese Medicine.

Table 6. Robustness test results for regression results for the whole biomedical industry

	Chemical Pharmaceutical	Traditional Chinese Medicine
RDS	-0.283**	0.329
	(-2.20)	(1.05)
lnAST	0.00127	-0.0258
	(0.09)	(-1.30)

LEV	-0.0193	0.0231
	(-0.36)	(0.56)
MAR	0.0534	-0.132**
	(1.17)	(-2.39)
_cons	0.0462	0.663
	(0.15)	(1.52)
N	410	280
R2	0.017	0.040
adj. R2	-0.241	-0.218

4.5 Regression results for before and after Covid-19 Epidemic

The regression results above compare the effects of R&D investment on a firm's profitability before and after the Covid-19 Epidemic.

Table 7. Regression results for before and after Covid-19 Epidemic

	Before Covid	After Covid
RDS	-0.697***	-0.00326
	(-8.39)	(-0.04)
lnAST	0.0343***	0.00631
	(4.25)	(1.40)
LEV	-0.135***	-0.110***
	(-5.20)	(-4.23)
MAR	-0.0646**	-0.0585**
	(-2.45)	(-2.25)
_cons	-0.590***	-0.0178
	(-3.38)	(-0.18)
N	678	452
R2	0.199	
adj. R2	-0.210	

t statistics in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

4.6 Robustness Test for Covid-19 pattern

In order to test the reliability of conclusion, the essay uses multiple regression model again, by using a new dependent variable: ROS. This means that the results below based on RDS-ROA&ROS. The new variable is added to increase one more indicator, which would test the results better.

The results gained form RDS-ROA and RDS-ROS are similar. Two results both demonstrate negative correlations. Therefore, the obtained pattern is reliable.

Table 8. Robustness test under Covid-19

	ROA	ROS
RDS	-0.405***	-0.843***
	(-6.55)	(-3.78)
lnAST	0.0102	0.0219
	(1.56)	(0.93)

LEV	-0.0318	-0.130
	(-1.29)	(-1.46)
MAR	-0.0246	-0.0834
	(-0.94)	(-0.88)
_cons	-0.117	-0.249
	(-0.82)	(-0.48)
N	1130	1130
R2	0.054	0.022
adj. R2	-0.186	-0.227

5. DISCUSSION

5.1Key findings

Table 4 demonstrates that the coefficient of RDS-ROA is very negative (-.405). Also, the p-value equals 0. We could see that the p-values of control variables (LnAST, LEV, MAR) are much more significant, and all have exceeded 0.1. The smaller the P-value, the more significant this factor is in the correlation we get. Additionally, the t-value (its absolute value is negatively correlated with the p-value). Therefore, the enormous absolute value of the t-value (e.g., 6.55) also confirmed the small p-value obtained.

These figures give us several conclusions: First of all, the R&D investment intensity is negatively correlated with the current profitability of firms due to the negative coefficient. Secondly, this negative correlation between dependent and independent variables is very significant (As it demonstrates a significant indicator of three stars***, also a very small P-value: 0). Finally, the control variables LnAST, LEV, and MAR are minorly significant to the dependent variable (As the P-values are very large and have exceeded 0.1, the significance indicators are zero stars). In addition, the Robustness test in Table 6 has shown the stability of this model by giving two conclusions: Firstly, in the chemical pharmaceutical category, firms' R&D investment is negatively correlated with their current profitability. Secondly, in the traditional Chinese medicine category, however, there is a positive correlation between variables. Therefore we can conclude an additional point that R&D investment in traditional Chinese medicine is more efficient.

Also, the table in Table 5 demonstrates the lag regression results for 1 phase, and we can see that the coefficient of RDS1 increases compared to the original RDS. Although the coefficient is still negative, the absolute value is smaller than the current relationship, approximately half as before. This pattern suggests that the R&D investment positively lags on a firm's profitability. Additionally, although RDS1 is still negatively correlated with ROA in the second phase, the situation has improved. Therefore, we could also deduce that the negative correlation would become positive as time goes on.

From Table 7, in the RDS column, we can find that, before the Covid-19 epidemic, R&D investment shows a very significant negative correlation with the firm's profitability (P-value less than 0.01). After the Covid epidemic, although the two variables are still negatively correlated, the negative relation is much weaker than before and is not significant. (P-value much closer to 0.01) Due to this, we can conclude that the R&D investments during the Covid-19 epidemic positively impacted the firm's future developments. Therefore our fourth hypothesis: The increase in profitability per unit of R&D expenditure is higher than before the pandemic has been confirmed. From the Robustness test demonstrated in Table 8, the results gained form RDS-ROA and RDS-ROS are similar. They both demonstrate negative correlations. Therefore, the obtained pattern is reliable.

5.2 Suggestions for firms' future developments

Based on the results obtained from 3.1.1 Regression results for the whole biomedical industry and 3.1.2 Lag regression results for one phase, some suggestions are provided.

On the one hand, when investing in R&D, the firms have to decide very carefully about the amount of money spent because, according to the results from regression, R&D investment has a very significant negative impact on a firm's current profitability; therefore, firms need to avoid going into massive debt. On the other hand, R&D investment has a lagged positive effect on a firm's profits. Therefore, R&D investment is necessary for firms to gain a more significant market share in the long term. When the firm has enough funds currently, investing in R&D would greatly benefit the profitability in the long run. Also, an accumulation in the capital could lead a firm to economies of scale, reducing the cost of production and increasing its market power. However, taking risks is necessary for medium and small-sized enterprises when there are too many competitors in an industry. Although borrowing may cause damage to current profits, it may allow a firm to emerge in the market and win customers.

What's more, for different secondary classifications in an industry, the efficiency of investment is also different. For example, R&D investment in traditional Chinese medicine would positively impact profitability in a relatively shorter period than the chemical-pharmaceutical category. Due to this, firms should consider their secondary classification when investing in R&D and decide the best time period for investing. If the investment in this classification is very efficient, then the expenditure on R&D could be gradual but continuous, as it would bring up the profitability quickly, leading to a continuous increase in profits. However, if the R&D expenditure has a very long lagging period, firms can focus on unique, innovative projects with a large amount of investment with enough funds. Consequently, although the current profitability would be hurt, there would be a considerable profit boost after several phases.

Two more suggestions are provided based on the results obtained from 4.6, Special patterns under Covid-19 Epidemic. Firstly, firms around the world would benefit from increasing R&D expenditure under current Covid situations, as the investment would reduce the negativity of correlation to a very large extent, just as mentioned in the confirmed hypothesis: an increase in profitability per unit of R&D expenditure is higher than before the pandemic. Therefore, the R&D investments would be more efficient during this period because people's demands on facemasks, disinfection supplies, and food increased dramatically when the epidemic went severe.

Secondly, after the complete normalization of the Covid-19 epidemic, firms could reduce their spending on R&D `as the rates of increase in profitability would reduce as well. This could be retrodicted as people will tend to return to the normal pace of consumption when the confidence in controlling the epidemic rises. Less money would be spent on corning products related to the Covid-19.

6. CONCLUSION

6.1 Key Findings

This essay uses regression models to find the relationship between R&D investments and firm's profitability. By comparing the regression results in different time periods, the essay finds the special patterns of relationship between the variables under the Covid-19 Epidemic. What is more, Robustness tests are applied to determine the stability of the relationship obtained from results.

Through the analysis in this essay, it can be concluded that R&D investment has a negative impact on firms' current profitability. However, the negative relationship will turn positive in several years, depends on the amount and which specific technology the firm invests in. What is more, the R&D investment during Covid-19 Epidemic is more efficient compared to general situations, which means that per unit spending will have a greater positive impact on firm's profitability.

Therefore, due to the findings above, this essay will help firms determine whether to increase investment in R&D in the future. In addition, the different secondary classification of firms in an identical industry will lead to different efficiency of R&D investment. In some particular classifications, the correlation between R&D investment and profitability will turn from negative to positive in a relatively short period. Also, under the global crisis of Covid-19, which has damaged the world economy to a large extent, this essay would help firms have a clearer view of investment during the normalization of the Covid epidemic and achieve further developments.

6.2 Future Studies

There are some limitations to this essay. First of all, the data being used in this essay was only from the biomedical industry in China, which is limited. Secondly, the business patterns and levels of being influenced by the Covid-Epidemic in different countries vary. Thirdly, the essay only discusses the lagging effect of one phase. However, some large-amount investments in R&D may require several years to put into use. Therefore, in future studies, researchers could focus on other major industries, for example, the retail industry. Also, the range of datasets could be wider, covering more areas of the world and using data from various industries to see the difference and therefore give more specific suggestions to firm's development. In addition, the time period for calculating lagging effects could be more extended, as this will help firms better decide whether and when to invest according to the effectiveness of R&D investment.

Due to above, this essay suggests that government subsidy to firms is essential for the international competitiveness of a country, as it will enable firms to increase R&D investment and avoid the risks of getting into huge debt, and to improve the quality of products. The essay believes that a general increase in firms' innovation levels in a country will bring up aggregate demand and increase consumption, consequently, lead to an economic growth. Therefore, this essay recommends that under the normalization of Covid-19, subsidy could increase to assist the recovery of firms, because investing during the Epidemic would get a higher return according to the results obtained from analysis, which will help firms to innovate new products, increase productivity, develop online selling systems to adapt the Covid-19 patterns, therefore increase profits.

REFERENCES

[1] Zhongjie Shao, Yuxin Zhu, Wen Xia, Xiaoming Li (2021). Empirical Study on the Relationship between Capitalized R&D Investment and Firm Profitability. *Inner Mongolia Science Technology & Economy*, 0(21), 49-51.

[2] Xiaoyan Wang, Yanqing Liang (2019). R&D Investment and Business Performance Under the Threshold of Growth Opportunity. *Research on Financial and Economic Issues*, 0(12), 88-95.

[3] Bin Guo (2006). Firm size, R&D, and performance: An empirical analysis on software industry in China. *Science Research Management*, 27(1), 121-126.

[4] Liming Gong, Shisong Jiang (2010). The Impact of R&D Investment on Enterprise Performance: Based on Empirical Research of ZheJiang YongKang Manufacturing Industry. *China Management studies*, 5(3), 19-35.

[5] Xuezhi Liu, Xiaohui Wang, Dong Zhang and Jing Huang (2017), An Analysis on the Relationship between R&D Investment and Performance of Chinese and American Industrial Enterprises. *Journal of Industrial Technological & Economics*, 36(11), 147-154.

[6] Yuhua Sheng, Lu Lu (2016). Inverted N-shaped Relationship Between R&D Investment and Corporate Performance: Based on the Internal Corporate Governance. *Nanjing Journal of Social Sciences*, 0(1), 32-38.

[7] Laixin Liang, Huanfeng Zhang (2005). An empirical study on the R&D inputs performance of high-tech enterprises. *Journal of Central South University: Social Sciences*, 11(2), 232-236.

[8] Chunmei Zheng, Dongsheng Wu (2022). A study about the Value-relevance of R&D Investment: Base on the Interfering Factor of Innovation. *Science & Technology Progress and Policy*, 39(3), 11-20.

[9] Zhihua Zhang, Xiaoyin Zhang (2022). R&D Investment Intensity, Internal Control and Enterprise Performance—A perspective based on the product market competition. *Journal of Yanbian University: Social Science Edition*, 55(1), 133-140.

[10] Peipei Xu (2016). Research on the Relationship between R&D Investment and Enterprise Performance—Based on the Data test of the Gem Manufacturing Enterprise. *Innovation Science and Technology*, 202(12), 26-28.