The Impact of Research and Development Investment on Stock Performance of Automotive Industry Company in China

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Abstract

This paper mainly studies whether the stocks of Chinese automotive companies will be affected by changes in the company's Research and development (R&D) investment. The regression model is used to analyze the correlation between R&D investment and stock performance of 61 listed auto industry companies in China from 2011 to 2020. The results show that when the company's R&D investment increases, the company have greater stock performance both on annual stock return and excess stock return. The company with higher total assets and leverage have a positive impact of R&D investment on stock return than lower one. And there is a certain lag in the impact of R&D investment on stock returns.

JEL Classification: G12, G31

Keywords: R&D investment, Stock performance, auto company

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1. Introduction

Research and development (R&D) investment, a process of creating value, plays a key role in the profitability and competitive advantage of enterprise innovation (Wang et al., 2013). In the automotive industry, there are differences between each product. Therefore, for auto manufacturing companies, timely introduction of excellent new products can enable the company to obtain higher production efficiency and profits (Clark et al., 1987). The company's after−tax profits and earnings have a clear positive impact on the company's stock price (Hunjra et al., 2014). The automotive industry is constantly innovating, such as changes in the size and shape of various cars, upgrades of internal parts and even changes in operating energy. The continuous R&D investment of auto manufacturers can promote the technological update of auto−related products and accelerate the release of new products. Related technical activities need to be used in almost the entire auto production process. If an auto company innovates production technology or creates new products in R&D, then the auto company may give priority to the release of successful products, which means that the R&D investment of an auto company can make the company's innovative products earlier enter the market and take advantage. This will enable auto companies to seize market share in advance to increase sales and profits, and ultimately affect their own company stock performances.

The main interest of this paper is to investigate the impact of Chinese auto companies' R&D investment on their stock performance. By observing the changes in the amount of R&D investment and stock performance of several Chinese auto companies in the past ten years, I will determine whether R&D investment will have a positive or negative impact on the stock performance of Chinese auto companies. The amount of R&D investment is basically different every year, increasing and decreasing. And this paper will find the relationship between these changes and the company's stock from the fluctuations of these amounts in different years. R&D investment is an indispensable part of the production and operation of auto companies. Unlike some previous studies that pay more attention to the direct impact of the amount of R&D investment on the company’s performance or revenue, this research does not focus on company performance, profit, market share, etc. Direction, but to look for how R&D affects stock performance.

This is a meaningful study. First, there is relatively little research in the academic field on the impact of auto company's R&D investment on the company's stock performance. And stocks are an important part of the development of a listed company. Its stock performance also directly reflects the company's development and operating conditions. Second, this study can determine whether the changes in R&D investment of auto companies within a certain time period is beneficial or detrimental to the company's operations. The auto company can learn from this research that the third of the time, the changes in R&D investment and the fluctuation of stock performance can also reflect whether the production and operation of the auto company are particularly dependent on the research and development of new projects. This can be reflected in whether the reduction in R&D investment will make the stock performance worse. If the car company is not particularly dependent on technological innovation, then the car company may have a greater advantage in other areas of the market.

The main finding of my research is that the R&D investment of China automotive industry corporation has a positive impact on stock returns and excess stock returns. The greater the company’s R&D investment, the higher the return on stocks. There may be a negative non-linear relationship between R&D investment and stock returns, but the impact of the non-linear relationship on stock returns is much smaller than the linear relationship between the two. At the same time, through group regression comparison, we found that companies with higher total assets and total leverage will increase stock returns when R&D investment increases. For companies with low total assets and low leverage, R&D investment does not have a significant impact on stock returns. However, we also found that R&D investment and P/B ratio, R&D investment and leverage multiplied by interaction terms have a moderating effect on R&D investment on stock returns. Through robustness result, we found the following two points. First, R&D investment between 2011 and 2015 will not have an impact on stock returns. The R&D investment after 2015 has a positive impact on stock returns, and this impact is higher than the impact calculated by all samples during the entire decade. Second, the annual R&D investment two to five years ago will have a positive impact on current stock returns. Moreover, we found that the longer the time interval between the selected R&D investment year and this year, the greater the impact of R&D investment on stock returns.

Our paper has the following three contributions to the previous literature. First, this paper contributes to the literature on the impact of R&D investment on company stocks. R&D investment is positively correlated with stock returns. (Li, 2011; Xu et al., 2007) and abnormal growth of R&D investment will have higher expected stock returns than market portfolios (Songur and Heavilin, 2017). However, other literature shows that R&D volatility and stock returns There is a negative correlation between them (Xiang et al., 2020). Therefore, what kind of impact the R&D investment has on the company's stock is still a controversial issue. And this paper provides evidence that R&D investment has a positive impact on the company's stock performance.

Second, this paper contributes to the literature on the impact of R&D investment in different periods on stock returns. The company’s R&D capital investment has an obvious intertemporal relationship with future stocks (Lev and Sougiannis, 1996). Our paper does prove that R&D investment has a lagging effect on stock returns. The R&D investment in the past two years or more can affect the current stock return, which also means that the current increase in R&D investment can increase the stock return in the coming years.

Third, this paper contributes to the literature on the influence of other factors of the company on the correlation between R&D investment and stock return. The positive correlation between R&D and stock returns will generate risks due to the company's financial deficiencies (Li, 2011). At the same time, in a more competitive industry, the greater the investment in R&D, the greater the return on stocks (Gu, 2016). Our paper provides new supporting evidence that companies with high total assets and high leverage have a more significant positive impact on stock returns by R&D investment.

The remaining part of this paper proceeds as follows. Section 2 is about the related literature review and develops hypothesis. Section 3 introduces the selected sample data and the method used. Section 4 is divided into three parts. The main regression results are to analyze the impact of R&D investment on stock returns. Additional results, seeking the nonlinear relationship between R&D investment and stock return, group regression, and interaction term effects. Robustness test, to study the impact of R&D investment on stock returns in different time periods and the lag of R&D investment. Section4 is the conclusion. The parts after these are references and tables.

2. Literature Review

Technological development and innovation are driven by R&D investment within the enterprise, which includes product innovation and productivity (Lin, 2012). The relationship between R&D investment and company stocks is a subject that has not yet fully matured and has some controversies. R&D investment can have a positive or negative impact on stocks, and it can also predict future stocks. At the same time, there are also differences in the returns and risks that different types of companies' R&D investment has on stocks. We will review the relevant literature in the following sections.

2.1. The positive impact of R&D investment on stocks

Some results indicate that R&D investment and company stocks are positively correlated in some respects. When R&D expenditures rise, the value of the company's benchmark financial reporting model, including earnings and book value, also rises (Xu et al., 2007). The company may try to exceed the company's profit forecast, and this will be punished by the stock market. At the same time, a temporary reduction in R&D investment at this stage is likely to lead to an increase in R&D investment costs later (Li et al., 2021). Li (2011) describes that although R&D is more inflexible than capital investment, it still has a positive relationship with stock returns. Eberhart et al. (2004) show that the increase in R&D investment is a more favorable investment for the company, but the sensitivity of the stock market and empirical performance to the returns generated by this investment is very low.

Songur and Heavilin (2017) use the method of Fama−Macbeth, it is found that the unusual growth of R&D investment will have a higher expected stock return than the market investment portfolio. Using the samples from 1992 to 2013, Brockman et al. (2017) conclude that the increase in return costs caused by the abnormal increase in R&D investment may be due to transaction costs rather than market inefficiency or risk neglect. High R&D investment can provide investors with higher stock returns because of high R&D efficiency making the company more popular in the market and buyers facing high risks in pursuit of high returns (Lin and Wang, 2016). Gharbi et al.

(2014) find that the volatility of the total number of shares is directly proportional to the R&D investment, and the lag of information triggered by R&D activities has led to the rise of stock volatility.

Xiang and He (2019) make an analysis of a sample of Chinese M&A transactions, the premium paid by the acquiring company for the R&D investment of the acquired company can alleviate the negative reaction of the stock market to mergers and acquisitions. At the same time, it also finds that acquirers who have mastered the technology in corporate mergers and acquisitions can better utilize R&D expenditures to obtain more profits (Kallunki and Laamanen, 2009).

Hypothesis 1: R&D investment have positive impacts on corporate stock returns.

2.2. The negative impact of R&D investment on stocks

Some results indicate that R&D investment and company stocks are negatively correlated in some respects. There is a negative relationship between R&D volatility and stock returns, which may be due to the fact that the market does not support earnings management to change R&D investment and expansionary cost adjustments (Xiang et al., 2020). It was discovered for the first time that the greater the R&D investment, the smaller the fluctuation of the stock price. This is because of the increase in stock liquidity. The increase in stock liquidity is caused by companies disclosing their own R&D information (Jiang et al., 2020). Saad and Zantout (2009) mention that the disclosure of the termination of the R&D plan will have some negative stock price effects, especially for small companies and their stocks. R&D cooperative development can reduce the risk of corporate innovation while also reducing the positive correlation between R&D and stock returns (Zhou et al., 2019). By studying the data from 1975 to 2012, it is concluded that the decline in R&D expenditure has resulted in a higher return on the company's stock. R&D investment is negatively correlated with changes in shareholder value (Chan et al., 2015). While R&D investment increases, companies with high stock volatility will produce lower stock returns and operating performance (Shen et al., 2013). Regarding knowledge spillover, that is, technological learning exchanges between enterprises, Fung (2006) shows that the low matching degree of information caused by knowledge spillover leads to the generation of downward fluctuations in stocks.

Hypothesis 2: R&D investment have negative impacts on corporate stock returns.

2.3. R&D investment forecast for future stocks

The company's R&D capital investment has an obvious inter–period relationship with future stocks (Lev and Sougiannis, 1996). By testing the effectiveness of the three factors of market capitalization, book assets, and net sales in the investment field of China's stock market, we can measure R&D investment and predict future stock returns (Lu, 2020). When companies in a small number of industries are increasing R&D investment, this innovative behavior is likely to affect the abnormal returns and performance of their peers. Based on your own R&D investment, you can predict the stock returns of other companies in the same industry (Jiang et al., 2016). One of the reasons for the abnormal return of stocks in the future may be due to the underestimation of the company's income from the increase in R&D investment in the market (Ali et al., 2012). When it comes to R&D capitalization, it is more affected by the increase in future earnings, rather than cost–based changes (Oswald and Zarowin, 2007).

2.4. The relationship between R&D investment and enterprise competition, risks, returns and other factors

The positive relationship between R&D and stock returns will generate risks due to the company's financial shortcomings (Li, 2011). The number of corporate patents can be used as a substitute for R&D investment in stock price movements (Yu and Hong, 2016). From the point of view of Gu (2016), it is predicted that the higher the R&D investment, the more intense the product market competition. In a competitive industry, companies need to compete with rivals for new products, but it is often easier to obtain higher expected stock returns in this industry. The stock prices of corporate competitors have a negative impact on R&D cooperation (Wu and Wei, 1998). The stock prices of companies with strong R&D and innovation intensity are undervalued to a certain extent. R&D can increase the valuation of the company's stock by internal and external investors, thereby reducing bias (Duqi et al., 2015). Excellent corporate governance can reduce the waste of R&D investment, thereby reaping higher stock returns (Chan et al., 2015). Unlike the stocks of companies with low levels of innovation, stocks of companies with high levels of innovation perform well in the face of crises (Adcock et al., 2014).

3. Data and Methodology

3.1. Data

This study uses CSMAR as the data source. We obtained information on the R&D investment and stock market of 65 Chinese automotive industry companies from 2011 to 2020 from CSMAR.

We received R&D investments from these 61 companies from CSMAR from December 31, 2011 to December 31, 2020. CSMAR data shows the stock code, stock abbreviation, annual final statistical date, R&D investment expenditure, R&D investment, R&D investment−operating revenue ratio. The statistical date for the R&D investment of these companies is December 31 of each year. Data related to R&D investment does not exist in other mid–year dates. Some companies' R&D investment–operating revenue data are not shown in some years.

Through CSMAR, we have obtained the stock–related information of these 61 companies from 2011 to 2020. This sample data from CSMAR provides us with the annual stock return, stock return and total assets of these companies in the past 10 years. From the sample data, the number of transaction proposals of these 61 companies is relatively similar. The annual changes of these sample data are important data for this study.

Moreover, we also obtained some information about factors that may affect stock returns through CSMAR. CSMAR's data shows the annual scale changes of these 61 companies, and their scale is measured in monetary terms, and the unit is CNY. And the scale of each year is summarized at the end of the year. In addition, the leverage, return on assets (ROA), ratio of net profit to fixed assets (NPFA) and return of equity (ROE) and price to book ratio (P/B ratio) of these companies are recorded on the last day of each year.

In addition, we download the daily Fama-French three factor model data from the official website of the Central University of Finance and Economics. We obtained the daily risk-free rate of return, the market rate of return, the simulated portfolio rate of return of the market value factor, and the simulated portfolio rate of return of the book-to-market value ratio factor. Among them, the Central University of Finance and Economics provides a market risk premium, which is equal to the market rate of return minus the risk-free rate of return. So, we need to calculate the market rate of return by ourselves. The annual data volume of the Fama-French three-factor model is 244, which means that 244 days of data are recorded in a year. We also obtained the daily stock returns of the 61 companies we selected from 2011 to 2020 from CSMAR. All companies have an average of 237 daily stock return data per year.

We will use several formulas and models to analyze the stock performance of these automotive industry companies from 2011 to 2020. At the same time, we will analyze the relationship between stock performance and changes in R&D investment.

3.2. Methodology

First, to investigate the determinants for stock returns, we use regression compute time−series t−statistics. In our main regression, there are 4 kinds of stock returns. The main regression is based on the following equation:

$$Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}, \tag{1}$$

where *Return* is the yearly stock return with cash flow reinvestment of each company, RD is the R&D investment. *Size* is the total assets of company, Lev is the leverage, ROA is the return on assets (ROA), $NPFA$ is the ratio of net profit to fixed assets, *ROE* is the return on equity and PB is the price to book ratio (P/B ratio). This is the regression with the first stock return.

The second kind of stock return is excess return. The equation to calculate it is the following:

$$ER_{i,t} = Return_{i,t} - Return_{m,t}, \tag{2}$$

where $ER_{i,t}$ is the excess return, $Return_{i,t}$ is the yearly stock return with cash flow reinvestment of each company and $Return_{m,t}$ is return of the market index for the current year. After we get the variable *ER*, we do the equation (1) with the *ER* instead of *Return*.

The third and fourth kind of stock return is the stock return from market model and Fama-French three factor model. We use daily stock return of each company return of the market index and daily variables in Fama-French three factor model in each year. We ran the following regression using the daily data of each company for each year. What we end up with will be the intercept regressed by each company through daily data every year, as the third and fourth stock return. Below are the regressions used to process the daily data:

$$Return_{i,t} = \alpha_1 + \beta_1 Return_{m,t} + U_{i,t} + \varepsilon_{i,t} \quad , \tag{3}$$

$$Return_{i,t} - R_f = \alpha_2 + \beta_1 (Return_{m,t} - R_f) + \beta_2 SMB_{i,t} + \beta_3 HML_{i,t} + U_{i,t} + \varepsilon_{i,t} \quad , \tag{4}$$

where R_f is the risk-free rate of return, SMB is the simulated portfolio rate of return of the market value factor, and HML is the simulated portfolio rate of return of the book-to-market value ratio factor. After those regressions, we get a serious of α_1 and α_2 for each company each year, which we use as stock return. And we do the equation (1) with α_0 and α_1 one each instead of *Return.*

Second, to find more relationships between variables, we use nonlinear quadratic relation and subgroup variable. Nonlinear quadratic relation is used to find the U-shaped relationship and subgroup variables is used to divide samples into two groups. The regressions are based on the following equations:

$$Return_{i,t} = \alpha_0 + \beta_0 RD^2_{i,t} + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t} , \tag{5}$$

$$MVar_1\text{: } Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t} , \tag{6}$$

$$MVar_2\text{: } Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t} , \tag{7}$$

where RD^2 is the square of RD. For the first classification of subgroup variable regression, $MVar_1$ is the group of companies whose variables are higher median than total companies' median. For the second classification of subgroup variable regression, $MVar_2$ is the group of companies whose variables have a lower median than total companies.

Third, to see the interaction between variables, we run the main regression with some additional interaction variables which equal to *RD* multiply by other control variable. The main regression is based on the following equation:

$$Return_{i,t} = \alpha_0 + \beta_0 RDVar_{i,t} + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}, \quad (8)$$

where $RDVar_{i,t}$ represents the interaction variables.

Fourth, to do the robustness checks, we use subperiod analysis and endogeneity test. In subperiod analysis, the panel A is about the data in 2015 and before and the panel B is about the data after 2015. Endogeneity test has two stages. The first stage we study how previous R&D investment affects latter R&D investment with other control variables. The second stage we study how previous R&D investment affects latter stock return with other control variables. The equation of subperiod analysis is (1). The regression for endogeneity test is based on the following equations:

$$Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t\text{-}q} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 PB_{i,t} + \beta_7 PE_{i,t} + U_{i,t} + \varepsilon_{i,t}, \quad (9)$$

where q is the number of former years we observe.

4. Results and Discussions

4.1. Main Results

As shown in Table 3, all variables are annual data of each variable. In this result, we have selected three dependent variables. The first dependent variable, *Return*, is the company's annual stock return. The second dependent variable, *ER*, is the company’s annual excess return, which we obtain through calculation (2). In the third dependent variable, we use equation (3) to perform the regression of each company within one year through the annual daily return of the market index as the independent variable to obtain the corresponding intercept of each company every year. And this intercept, we call α_1 , is our third dependent variable. Regarding the fourth dependent variable, we use equation (4), which is the Fama-French three factor model. Similarly, find the intercept of each company for each year as α_2 . And these four dependent variables are stock returns.

Through Table 3, we found that under random effects, the p-value of *RD* in the regression with *Return* as the dependent variable is less than 0.01. In this regression, 45.37% of *Return* changes can be fully explained by changes in *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*. Under the fixed effect, the p-value of *RD* in the regression with *ER* as the dependent variable is also less than 0.01. In this regression, 27.02% of the *ER* changes can be completely explained by the changes in *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*. In both cases, the *RD* is statistically significant at the 1% level. In addition, from the F test, we found that the p-value is 0.0000, which means that the regression rejects the assumption that all variable coefficients are equal to 0. However, we found that when α_1 and α_2 were used as the dependent variables, *RD* produced a p-value greater than 0.1 in the regression. This means that in these two regressions, *RD* is not statistically significant.

By observing the coefficient, the results show that the economically significant. In the regression with *Return* as dependent variable, the coefficient on *RD* is 0.0767 when the control variables are included. Thus a 100% inset R&D investment, which is lower than one standard deviation, estimates an increase of 767 bias points in annual stock returns. In the regression with *ER* as dependent variable, the coefficient on *RD* is 0.1705 when the control variables are included. Thus a 100% inset R&D investment, which is lower than one standard deviation, estimates an increase of 1705 bias points in annual stock returns. By comparing these two sets of coefficients, we find that *RD* has higher economic significance in the regression with *ER* as dependent variable.

Table 3 shows that the annual R&D investment of auto companies has a positive impact on stock returns and excess stock returns. For the annual stock return, for every unit increase in R&D investment, the company's stock return will increase by 7.67%. Corporate total assets, ROE, and price-to-earnings ratio will also have a significant positive impact on stock returns. The company's ROA will have a negative impact on stock returns, but the impact is not as significant as R&D investment. For annual excess stock returns, for every unit increase in R&D investment, the company's stock returns will increase by 17.05%. Corporate ROE and P/B ratio will also have a significant positive impact on stock returns. Compared with annual stock returns, R&D investment has a stronger impact on annual excess stock returns. And the impact of other control variables on excess stock returns is not as large as R&D investment. Because although in the regression of excess stock returns as a dependent variable, ROE has greater economic significance for excess stock returns, but it is significant at the level of 5%, while R&D investment is significant at the level of 1%.

4.2. Additional Results

4.2.1. Nonlinear quadratic relation

In Table 4, our response variable is the same as Table 3, which is still divided into four parts: *Return*, *ER*, α_1 and α_2. To find the nonlinear quadratic relationship between the main research variable *RD* and stock returns, we have added a new variable to the four regressions in Table 4, RD^2, which is the square of *RD*.

Through Table 4, we found that only when Return is used as the dependent variable, RD^2 are statistically weakly significant in the regression. RD^2 is significant at the 10% level. 43.61% of the return changes can be completely explained by the changes in RD^2, *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*. In the other three regressions, the p-value of RD^2 is greater than 0.1. This means that RD^2 are not statistically significant in these three regressions.

Since only one regression of RD^2 is significant, then we only observe the regression where the dependent variable is *Return*. In this regression, the coefficient of RD^2 is -0.0030. Thus a 100% inset square of R&D investment, which is lower than one standard deviation, estimates a decrease of 300 bias points in annual stock returns. Then this regression is also economically significant.

This result shows that there is a negative relationship between the square of R&D investment and annual stock return because the coefficient of the square of R&D investment is negative. For every unit increase in the square of R&D investment, the company's stock return will decrease by 0.3%. In other words, the U-shaped relationship between R&D investment and annual stock returns is an inverted U-shaped relationship. This shows that the company's annual stock return will reach its maximum when it reaches a certain square of R&D investment. This means that the greater the R&D investment, does not mean that the company will be able to obtain higher stock returns. This also confirms the non-linear quadratic relationship between the two. However, in this regression, R&D investment is more significant than the square of R&D investment for annual stock returns. Therefore, R&D investment may still have a persistently positive impact on stock returns.

4.2.2. Subgroup variable

In Table 5, we divided each company's sample into two groups based on the comparison of its total assets and leverage with the median of the total assets and leverage of all company samples. The first group of companies has higher total assets and leverage. The second group of companies has lower total assets and leverage. Then we look at the regression performance of two groups of samples with different sizes of control variables according to the grouping.

Through Table 5, we found that companies with higher total assets have a statistically significant *RD* at the 10% level. Among them, 45.26% of the *Return* changes can be completely explained by the changes in *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*. At the same time, for companies with higher leverage, the *RD* is statistically significant at the 5% level. Among them, 54.29% of the return changes can be completely explained by the changes in *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*. For companies with lower total assets and leverage, their *RD* is not significant in the regression, with a p-value greater than 0.1.

By observing the coefficient, the results show that the economically significant. In companies with higher total assets, the coefficient on *RD* is 0.0468 when the control variables are included. Thus a 100% inset R&D investment, which is lower than one standard deviation, estimates an increase of 468 bias points in annual stock returns. In companies with higher leverage, the coefficient on *RD* is 0.484 when the control variables are included. Thus a 100% inset R&D investment, which is lower than one standard deviation, estimates an increase of 484 bias points in annual stock returns.

Therefore, in a company with high total assets, when R&D investment increases by one unit, the stock return will generate a growth rate of 4.68%. In a highly leveraged company, when R&D investment increases by one unit, the stock return will have a growth rate of 4.84%. From this, we can infer that in a company with high total assets and high leverage, R&D investment has a positive effect on the stock return. Have a positive impact. The R&D investment of companies with lower total assets and leverage may not have a significant impact on stock returns. But from Table 4, we can also see that after being divided into two groups, the impact of R&D investment on stock returns has become less significant than before. And the impact of R&D investment has become smaller, because even for companies with high total assets and high leverage, the growth rate of R&D investment on stock returns has decreased by about 3%. This may be due to the fact that in the new sample group, other control variables like *Size, ROA, ROE,* or *PB* have a higher and more significant impact on stock returns.

4.2.3. Interaction variable

As shown in Tables 6, we studied the effect of interaction variables obtained by multiplying *RD* with other control variables on stock returns. Here, for dependent variables, we use the annual stock return and annual excess stock return obtained in the main result. We added each interaction variable separately to the main regression, which is the equation (1). And we created an equation (8) suitable for Tables 6 based on the equation (1). Table 6 describes the annual stock return as the dependent variable and the results of annual excess stock returns as a dependent variable.

By observing Table 6, we found that only the interaction variable *RDPB*, which is equal to *RD* multiplied by *PB*, is statistically significant for stock returns. And it is significant at the 1% level. 7.64% of the *Return* change can be completely explained by the changes of *RDPB*, *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*. There is only the interaction variable *RDLev*, which is equal to *RD* multiplied by *Lev*, and *RDPB* is statistically significant for excess stock returns. Both *RDLev* and *RDPB* are significant at the 5% level. About 5% of the *ER* of both sets of interactive variables can be fully explained by *RDLev* or *RDPB* and *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*.

Next, we study the coefficient of the three significant sets of data. For the regression with annual stock returns as the dependent variable, for every increase in the number of *RDPB* by 1, the annual stock return will rise by 0.0229. For the annual excess stock return as the dependent variable of the regression, for each increase in the number of *RDLev* by 1, the annual excess stock return will fall by 0.0127. For each increase in the number of *RDPB* by 1, the annual excess stock return will rise by 0.0165. Therefore, we believe that this result is economically significant.

By observing that table, we find that the interaction variable obtained by multiplying R&D investment and price-to-book ratio is significant for both annual stock returns and annual excess stock returns. This shows that their moderating effects on the returns of the two stocks are significant. And the coefficients of the two interaction variables are greater than 0, then it means that they both have a positive impact on stock returns, that is, a positive moderating effect. At the same time, although the interaction variable obtained by multiplying R&D investment and leverage has a significant moderating effect on the annual excess stock return, since its coefficient is less than 0, it is negative for the annual excess stock return. In addition, we also found that when stock returns are affected by *RDPB*, *RD* is no longer significant for stock returns. When stock returns are affected by *RDLev*, *RD* remains significant for stock returns. This may indicate that the moderator variable *RDPB* has a greater impact on stock returns than *RDLev*.

4.3. Robustness Checks

4.3.1. Subperiod analysis

As shown in Table 7, we assume that panel A represents the sample from 2011 to 2015, and panel B represents the sample from 2016 to 2020. In this way, we have grouped all samples according to time period. Run regression independently for each panel.

We found that *RD* was statistically significant in panel B at the 1% level. In this panel, 25.08% of the *Return* changes can be completely explained by *RD*, *Size*, *Lev*, *ROA*, *NPFA*, *ROE* and *PB*. However, *RD* is not statistically significant in panel A from 2011 to 2015. In panel A, only *ROE* and *PB* are significant at the 1% level.

In panel B, the coefficient of *RD* is 0.0875. This means that in panel B, every time *RD* rises by 1, the stock return will get a growth rate of 8.75%. This result is also economically significant. From this we can see that from 2011 to 2015, R&D investment may not have a significant impact on stock returns. In the past few years, the impact of ROE and price-to-book ratio on stock returns may be far greater than that of R&D investment. From 2016 to 2020, we found that R&D investment has a positive impact on stock returns. But stock returns in the past few years are still affected by total assets that are also significant at the 1% level, and the impact of total assets on stock returns is negative. But it can be judged according to the coefficient that the impact of total assets will be less than R&D investment.

4.3.2. Endogeneity test

In Table 8, we observe the impact of R&D investment from one to five years ago on stock returns. We stipulate that the variable *RD1* is the R&D investment of the previous year, *RD2* is the R&D investment of two years ago, *RD3* is the R&D investment of three years ago, *RD4* is the R&D investment of four years ago and *RD5* is the R&D investment of five years ago.

As seen in Table 8, we found that the p value of *RD1* is not less than 0.1, so it is not statistically significant. *RD2*, *RD3*, *RD4* and *RD5* are all statistically significant at the 5% level.

Through the data shown in Table 8, we find that *RD2* has a coefficient of 0.1327, *RD3* has a coefficient of 0.2037, *RD4* has a coefficient of 0.3224 and *RD5* has a coefficient of 0.3947. Thus a 100% inset *RD2*, which is lower than one standard deviation, estimates an increase of 1327 bias points in annual stock returns. Thus a 100% inset *RD3*, which is lower than one standard deviation, estimates an increase of 2037 bias points in annual stock returns. Thus a 100% inset *RD4*, which is lower than one standard deviation, estimates an increase of 3224 bias points in annual stock returns. This result show that the economically significant. Thus a 100% inset *RD5*, which is lower than one standard deviation, estimates an increase of 3937 bias points in annual stock returns. This result show that the economically significant.

From this table, we have the following conclusions. The R&D investment in the previous year has no effect on the company's stock return this year. However, R&D investment two years ago, three years ago, and four years ago has a positive impact on the company's stock returns this year. From Table 3, we know that the impact of R&D investment in that year on stock returns was 7.67%. The impact of R&D investment two years ago on stock returns was 13.27%, the impact of R&D investment three years ago on stock returns was 20.37%, the impact of R&D investment three years ago on stock returns was 32.24% and the impact of R&D investment three years ago on stock returns was 39.47%. This shows that R&D investment There is a certain lag in the impact on stock returns. In other words, current R&D investment may have a greater impact on stock returns in the next two years and beyond.

5. Conclusions

For China Auto Industry Companies, the impact of annual R&D investment on the company's stock performance is positive in most cases.

When the company increases its R&D investment by one unit, the company's stock return will increase by 7.67%, and the company's excess stock return will increase by 17.05%. However, after considering the significance of other control variables and the size of the coefficients, we found that the biggest impact on the company's stock is R&D investment. For the company's excess return, it is also the R&D investment that has the greatest impact on it. The stock returns under the influence of the market model and the Fama-French three factor model will not be affected by the company's R&D investment. Divided by time period, from 2011 to 2015, the impact of R&D investment on stock returns was not significant. Stock returns are more affected by ROE and price-to-book ratio. From 2016 to 2020, we found that R&D investment has a positive impact on stock returns.

R&D investment only has a non-linear quadratic relation with the company's annual stock return and is a U-shaped relation. But we found that this is an inverted U-shaped relationship, which means that there may be a maximum stock return. This means when R&D investment increases in the previous stage, stock returns will increase, but after the highest point of stock returns, the continued increase in R&D investment may lead to a decline in stock returns. However, we found that when we return the square of R&D investment and R&D investment together. The positive impact of R&D investment on stocks is far greater than the inverted U-shaped relationship between R&D investment and stock returns. Therefore, R&D investment may have been having a positive impact on stock returns. However, there is no U-shaped relation between excess stock returns and stock returns under the influence of the market model and the Fama-French three factor model and R&D investment.

For companies with higher total assets and leverage, their R&D investment has a positive impact on stock returns. Regardless of whether it is a company with high total assets or a highly leveraged company, for every additional unit of their R&D investment, stock returns will rise by approximately 5%. For companies with lower total assets and leverage, R&D investment has no effect on stock returns.

The interaction variables obtained by multiplying R&D investment and price-to-book ratio have a positive and significant moderating effect on stock returns and excess stock returns. The interaction variables obtained by multiplying R&D investment and leverage have a negative and significant moderating effect on excess stock returns. The interaction variable obtained by multiplying R&D investment with every control variable except the price-to-book ratio has no moderating effect on stock returns. The interaction variable obtained by multiplying R&D investment with every control variable except the leveraged price-to-book ratio has no moderating effect on excess stock returns.

The R&D investment two years ago, three years ago, four years ago and five years ago all have a positive impact on stock returns. And the further the time period, the greater the impact of R&D investment on stock returns. This shows that there is a certain lag in the impact of R&D

investment on stock returns. In other words, the current R&D investment may have a greater impact on stock returns in the next two years and beyond.

This paper mainly contributes to the impact of R&D investment on stock returns. We have proved that the company's R&D investment has a positive impact on stock returns. And over time, the lag of R&D investment on stock returns has become more obvious. This shows that if Chinese auto industry companies want to obtain a better return on stocks, they need to increase R&D investment. At the same time, for investors, a company with higher R&D investment will have better stock performance. If an investor wants to choose a stock of a Chinese automobile industry company as an investment, it is a good choice to observe the data of R&D investment. After comparing R&D investment, investors should also choose a company with higher total assets and leverage or observe the company's R&D investment in previous years.

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Table 1: Sample Statistics of Chinese Auto Industry Companies

This table provides descriptive statistics on the R&D investment and stock performance samples of listed companies in the Chinese automotive industry from 2011 to 2020. Among them, *RD* is the R&D investment, *Return, ER,* α_1 *and* α_2 are different stock returns, *Size* is the total assets, *Lev* is the leverage, *ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. *ER* is the excess stock return. α_1 is the intercept from market model. α_2 is the intercept from Fama-French three factor model. The final sample included 368 observations from 61 Chinese auto industry companies. All data are from CSMAR and Central University of Finance and Economics.

Variables	Observations	Mean	StdDev	Min	Median	Max	Skew	Kurt
Return	368	0.0887	0.4834	-0.5623	-0.0342	3.3249	1.9471	6.5313
ER	368	-0.0279	0.5048	-3.3805	-0.0814	3.0222	-0.1626	10.7767
α_1	368	0.0002	0.0015	-0.0034	-0.0000	0.0069	1.4949	3.8543
α_2	368	0.0004	0.0016	-0.0035	0.0000	0.0092	1.9943	6.5706
RD	368	0.9678	2.0789	0.0008	0.1807	15.9219	4.0735	20.5996
Size	368	37.2728	103.7945	0.6321	7.5712	919.4148	5.8662	39.0979
Lev	368	3.1317	5.8156	1.0841	1.7028	80.5484	8.8227	100.2084
ROA	368	0.0498	0.0362	0.0005	0.0426	0.1565	0.7108	-0.2593
NPFA	368	0.2937	0.2817	0.0022	0.2107	2.0386	1.8802	5.1767
ROE	368	0.1009	0.0686	0.0014	0.0930	0.3385	0.7801	0.3183
PB	368	11.3506	30.0743	0.5432	2.4292	315.4956	6.1286	47.4453

Table 2: Correlations

This table shows the correlation between annually variables, using the sample of 61 Chinese auto industry companies from 2011 to 2020. *RD* is the R&D investment, *Return, ER,* α_1 *and* α_2 are different stock returns, *Size* is the total assets, *Lev* is the leverage*, ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. *ER* is the excess stock return. α_1 is the intercept from market model. α_2 is the intercept from Fama-French three factor model. These 368 samples are from CSMAR and Central University of Finance and Economics.

	Return	*ER*	α_1	α_2	*RD*	*Size*	*Lev*	*ROA*	*NPFA*	*ROE*	*PB*
Return	1.000										
ER	0.742 (0.000)	1.000									
α_1	0.370 (0.000)	0.321 (0.000)	1.000								
α_2	0.242 (0.000)	0.190 (0.000)	0.868 (0.000)	1.000							
RD	0.089 (0.089)	0.026 (0.621)	0.049 (0.345)	0.062 (0.236)	1.000						
Size	0.048 (0.360)	0.022 (0.671)	0.033 (0.525)	0.043 (0.401)	0.922 (0.000)	1.000					
Lev	-0.001 (0.983)	-0.080 (0.124)	-0.040 (0.440)	-0.032 (0.540)	0.026 (0.624)	-0.023 (0.661)	1.000				
ROA	-0.006 (0.912)	0.072 (0.170)	0.148 (0.004)	0.217 (0.000)	0.034 (0.517)	0.065 (0.211)	-0.357 (0.000)	1.000			
NPFA	0.021 (0.685)	0.081 (0.119)	0.115 (0.027)	0.177 (0.001)	0.205 (0.000)	0.285 (0.000)	-0.288 (0.000)	0.768 (0.000)	1.000		
ROE	0.060 (0.248)	0.141 (0.007)	0.167 (0.001)	0.211 (0.000)	0.144 (0.006)	0.176 (0.001)	-0.353 (0.000)	0.796 (0.000)	0.739 (0.000)	1.000	
PB	0.107 (0.040)	0.095 (0.069)	0.040 (0.448)	-0.025 (0.628)	-0.134 (0.010)	-0.100 (0.055)	0.007 (0.901)	-0.197 (0.000)	-0.199 (0.000)	-0.222 (0.000)	1.000

Table 3: Main Regression Results

The table indicates results for the in−sample regression:

$$Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}$$

This table reports the regression results of these annually variables of those auto companies. *RD* is the R&D investment, *Return, ER,* α_1 *and* α_2 are different stock returns, *Size* is the total assets, *Lev* is the leverage*, ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. We do the regression again when *ER,* α_1 and α_2 as dependent variable. *ER* is the excess stock return. α_1 is the intercept from market model. α_2 is the intercept from Fama-French three factor model. The table show that data only become significant when dependent variables are *Return* and *ER* in this sample. And the results of regression are from random in dependent variable *Return* and fixed in dependent variable *ER*. Therefore, in the following tables we use random effect for regression with *Return* and fixed effect for regression with *ER* to get the additional results and do the robustness checks. *- stat. sign. At 10% level; **- stat. sign. At 5% level; ***- stat. sign. at 1% level. Sample period is from 2011 to 2020. These 368 samples are from CSMAR and Central University of Finance and Economics.

	Return	*ER*	α_1	α_2
RD	0.0767***	0.1705***	0.0001	0.00005
	(0.0239)	(0.1466)	(0.0001)	(0.0001)
Size	-0.0012***	-0.0021	-0.0000	-0.0000
	(0.0004)	(0.0021)	(0.0000)	(0.0000)
Lev	-0.0001	-0.0023	0.0000	0.0000
	(0.0022)	(0.0037)	(0.0000)	(0.0000)
ROA	-1.5944**	-2.6024	0.0018	0.0102
	(0.7785)	(3.1080)	(0.0088)	(0.0094)
NPFA	0.0827	0.1014	0.0007	0.0005
	(0.0739)	(0.2136)	(0.0007)	(0.0008)
ROE	1.0544**	2.1440*	0.0016	0.0011
	(0.4275)	(1.2640)	(0.0030)	(0.0037)
PB	0.0028***	0.0055***	0.0000***	0.0000**
	(0.0010)	(0.0015)	(0.0000)	(0.0000)
_cons	-0.4777***	-0.3243	-0.0010**	0.0000
	(0.0449)	(0.1998)	(0.0004)	(0.0001)
N	368	368	368	368
r2	0.4537	0.2702	0.1256	0.1138

Table 4: Nonlinear quadratic relation

The table indicates results for the in−sample regression:

$$Return_{i,t} = \alpha_0 + \beta_0 RD^2{}_{i,t} + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}$$

The table shows the regression of nonlinear quadratic relation of annually variables. *Return ER,* α_1 *and* α_2 are different stock returns, *RD* is the R&D investment, RD^2 is the square of R&D investment,, *Size* is the total assets, *Lev* is the leverage*, ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. We do the regression again when *ER,* α_1 and α_2 as dependent variable. *ER* is the excess stock return. α_1 is the intercept from market model. α_2 is the intercept from Fama-French three factor model. This shows the U-shaped relationship between R&D investment and stock return 2011 to 2020. *- stat. sign. At 10% level; **- stat. sign. At 5% level; ***- stat. sign. at 1% level. These 368 samples are from CSMAR and Central University of Finance and Economics.

	Return	*ER*	α_1	α_2
RD^2	-0.0030*	-0.0061	0.0000	-0.0000
	(0.0018)	(0.0072)	(0.0000)	(0.0000)
RD	0.0850***	0.2170	0.0001	0.0001
	(0.0262)	(0.1887)	(0.0001)	(0.0001)
Size	-0.0007*	-0.0008	-0.0000	-0.0000
	(0.0004)	(0.0015)	(0.0000)	(0.0000)
Lev	-0.0007	-0.0021	0.0000	0.0000
	(0.0022)	(0.0036)	(0.0000)	(0.0000)
ROA	-1.4148*	-2.2132	0.0036	0.0072*
	(0.8282)	(3.0903)	(0.0043)	(0.0042)
NPFA	0.0419	0.0566	-0.0001	-0.0002
	(0.0946)	(0.2085)	(0.0005)	(0.0005)
ROE	1.0287**	2.2165*	0.0030*	0.0036
	(0.4085)	(1.2806)	(0.0015)	(0.0023)
PB	0.0029***	0.0056***	0.0000	0.0000
	(0.0010)	(0.0016)	(0.0000)	(0.0000)
	(0.0831)	(0.0869)	(0.0004)	(0.0004)
_cons	-0.4835***	-0.3844	-0.0011***	-0.0014***
	(0.0448)	(0.2354)	(0.0003)	(0.0003)
N	368	368	368	368
r2	0.4361	0.2737	0.1121	0.0993

Table 5: Subgroup variable

The table indicates results for the in−sample regression:

$$Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}$$

In this table, we divide all samples into two group. The classification standard is to look at the difference between the variables of each company and the median variables of all companies. Results in $MVar_1$ conclude the companies those who have higher total assets or leverage than the total companies' median. Results in $MVar_2$ conclude the companies those who have lower total assets or leverage than the total companies' median. We compare two groups to find out which group' R&D investment affects stock return more. *Return* is stock returns, *RD* is the R&D investment, *Size* is the total assets, *Lev* is the leverage*, ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. *- stat. sign. At 10% level; **- stat. sign. At 5% level; ***- stat. sign. at 1% level. Samples are from 61 Chinese auto companies 2011 to 2020 from CSMAR and Central University of Finance and Economics.

	Return ($MVar_1$)	*Return* ($MVar_2$)	*Return* ($MVar_1$)	*Return* ($MVar_2$)
RD	0.0468*	-0.2091	0.0484**	0.0610
	(0.0254)	(0.2124)	(0.0199)	(0.0583)
Size	-0.0008**	0.0046	0.0003	-0.0010
	(0.0004)	(0.0078)	(0.0006)	(0.0010)
Lev	-0.0004	-0.0002	0.0001	0.0251
	(0.0024)	(0.0081)	(0.0017)	(0.0187)
ROA	-2.6797***	-0.5410	-2.4149	-2.5560***
	(0.9362)	(1.2206)	(1.8995)	(0.7583)
NPFA	-0.0677	0.1337	0.4125	0.0122
	(0.0671)	(0.2352)	(0.3987)	(0.0598)
ROE	2.1587***	0.4705	0.6685	1.8064***
	(0.6268)	(0.3507)	(0.5757)	(0.5844)
PB	0.0043*	0.0018	0.0029***	0.0035
	(0.0026)	(0.0011)	(0.0010)	(0.0025)
_cons	-0.5060***	-0.4761***	-0.4766***	-0.5200***
	(0.0744)	(0.0625)	(0.0605)	(0.0941)
N	184	184	182	186
r2	0.4526	0.5417	0.5429	0.3827

Table 6: Interaction variable

The table indicates results for the in−sample regression:

$$Return_{i,t} = \alpha_0 + \beta_0 RDVar_{i,t} + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}$$

In this table, we study whether there is interaction between variables. The variable *RDVar* represents *RD* multiplied by other control variables. *RDSize* is *RD* multiplied by *Size*, *RDLev* is *RD* multiplied by *Lev*, *RDROA* is *RD* multiplied by *ROA*, *RDNPFA* is *RD* multiplied by *NPFA*, *RDROE* is *RD* multiplied by *NPFA*, *RDPB* is *RD* multiplied by *PB*. *Return* is stock returns, *RD* is the R&D investment, *Size* is the total assets, *Lev* is the leverage, *ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. *-stat. sign. At 10% level; **- stat. sign. At 5% level; ***- stat. sign. at 1% level. Samples are from 61 Chinese auto companies 2011 to 2020 from CSMAR.

Panel A Annual stock return as dependent variable						
	Return	*Return*	*Return*	*Return*	*Return*	*Return*
RD	0.0692**	0.1024**	0.0875**	0.0810**	0.0859**	-0.0006
	(0.0333)	(0.0400)	(0.0354)	(0.0320)	(0.0361)	(0.0392)
RDSize	-0.0001					
	(0.0001)					
RDLev		-0.0053				
		(0.0059)				
RDROA			-0.2188			
			(0.5138)			
RDNPFA				-0.0272		
				(0.0467)		
RDROE					-0.0717	
					(0.2475)	
RDPB						0.0229***
						(0.0065)
Size	-0.0002	-0.0016**	-0.0013*	-0.0011	-0.0013*	-0.0004
	(0.0011)	(0.0007)	(0.0007)	(0.0008)	(0.0007)	(0.0007)
Lev	0.0000	0.0095	0.0005	0.0005	0.0005	0.0018
	(0.0047)	(0.0111)	(0.0047)	(0.0047)	(0.0047)	(0.0046)
ROA	-1.5467	-1.7466	-1.8331	-1.9420	-1.8717	-1.7613
	(1.3465)	(1.3320)	(1.3288)	(1.3305)	(1.3257)	(1.3041)
NPFA	0.0056	0.0709	0.0794	0.1037	0.0740	0.0733
	(0.1645)	(0.1574)	(0.1596)	(0.1686)	(0.1587)	(0.1549)
ROE	1.1883*	1.2698*	1.3090**	1.2754*	1.3078*	1.1739*
	(0.6486)	(0.6476)	(0.6603)	(0.6487)	(0.6733)	(0.6377)
PB	0.0024***	0.0023***	0.0024***	0.0024***	0.0023***	0.0008
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0010)
_cons	-0.0252	-0.0510	-0.0299	-0.0294	-0.0273	-0.0224
	(0.0591)	(0.0683)	(0.0631)	(0.0610)	(0.0636)	(0.0581)
N	368	368	368	368	368	368
r2	0.0493	0.0469	0.0453	0.0457	0.0450	0.0764
F	2.3251	2.2087	2.1291	2.1499	2.1164	3.7138

Panel B Excess stock return as dependent variable						
	ER	*ER*	*ER*	*ER*	*ER*	*ER*
RD	0.0206	0.0754*	0.0084	0.0240	-0.0011	-0.0350
	(0.0348)	(0.0416)	(0.0370)	(0.0335)	(0.0376)	(0.0413)
RDSize	-0.0000					
	(0.0001)					
RDLev		-0.0127**				
		(0.0061)				
RDROA			0.5303			
			(0.5365)			
RDNPFA				0.0277		
				(0.0488)		
RDROE					0.3737	
					(0.2579)	
RDPB						0.0165**
						(0.0069)
Size	-0.0001	-0.0010	-0.0007	-0.0008	-0.0010	0.0002
	(0.0012)	(0.0007)	(0.0007)	(0.0009)	(0.0008)	(0.0007)
Lev	-0.0034	0.0182	-0.0031	-0.0033	-0.0029	-0.0024
	(0.0049)	(0.0115)	(0.0049)	(0.0049)	(0.0049)	(0.0049)
ROA	-1.5440	-1.3307	-1.7323	-1.5657	-1.6422	-1.5554
	(1.4106)	(1.3857)	(1.3875)	(1.3909)	(1.3819)	(1.3754)
NPFA	0.0082	0.0315	-0.0003	-0.0097	-0.0023	0.0293
	(0.1724)	(0.1638)	(0.1666)	(0.1762)	(0.1654)	(0.1634)
ROE	1.7660***	1.8209***	1.6534**	1.7638***	1.5087**	1.7264**
	(0.6795)	(0.6737)	(0.6895)	(0.6782)	(0.7019)	(0.6725)
PB	0.0022**	0.0022**	0.0021**	0.0022**	0.0021**	0.0011
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0010)
_cons	-0.1562**	-0.2285***	-0.1321**	-0.1458**	-0.1197*	-0.1563**
	(0.0619)	(0.0710)	(0.0659)	(0.0638)	(0.0662)	(0.0613)
N	368	368	368	368	368	368
r2	0.0435	0.0543	0.0457	0.0440	0.0487	0.0582
F	2.0384	2.5788	2.1502	2.0646	2.2967	2.7734

Table 7: Subperiod analysis

The table indicates results for the in−sample regression:

$$Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}$$

This table shows the regression in two time periods. Panel A matches the samples from 2011 to 2015. Panel B matches the samples after 2015. *RD* is the R&D investment, *Return* is the stock return, *Size* is the total assets, *Lev* is the leverage, *ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. *- stat. sign. At 10% level; **- stat. sign. At 5% level; ***- stat. sign. at 1% level. The total Sample period is from December 31 2011 to December 31 2020. All data are from CSMAR.

	Return (Panel A)	*Return* (Panel B)
RD	-0.0525	0.0875^{***}
	(0.0671)	(0.0313)
Size	0.0010	-0.0014^{***}
	(0.0012)	(0.0005)
Lev	0.0174	-0.0012
	(0.0113)	(0.0022)
ROA	-1.0170	-1.3643^{**}
	(1.3522)	(0.6784)
ROE	1.6488^{***}	0.7714
	(0.6360)	(0.4941)
NPFA	-0.1716	0.1507^{*}
	(0.1968)	(0.0916)
PB	0.0043^{***}	-0.0007
	(0.0012)	(0.0007)
_cons	-0.5473^{***}	-0.2693^{***}
	(0.0869)	(0.0491)
N	132	236
r2	0.5866	0.2508

Table 8: Endogeneity test

The table indicates results for the in−sample regression:

$$Return_{i,t} = \alpha_0 + \beta_1 RD_{i,t\text{-q}} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPFA_{i,t} + \beta_6 ROE_{i,t} + \beta_7 PB_{i,t} + U_{i,t} + \varepsilon_{i,t}$$

In this table, we make two stages to do the regression. The first stage is to find out the relationship between *RD* in different years. The second stage is to find whether the former *RD* will affect stock return. *RD1* presents the previous year R&D investment. *RD2* presents the R&D investment two years ago. *RD3* presents the R&D investment three years ago. *RD4* presents the R&D investment four years ago. *RD5* presents the R&D investment five years ago. *Return* is the stock return, *Size* is the total assets, *Lev* is the leverage, *ROA* is the return of assets, *NPFA* is the net profit to fixed assets, *ROE* is the return on equity and *PB* is the price to book ratio. *- stat. sign. At 10% level; **- stat. sign. At 5% level; ***- stat. sign. at 1% level. The total sample period is from December 31 2011 to December 31 2020. And it concludes 61 Chinese auto industry companies.

	Return	*Return*	*Return*	*Return*	*Return*
RD1	0.0568				
	(0.0498)				
RD2		0.1327^{**}			
		(0.0566)			
RD3			0.2037^{**}		
			(0.0909)		
RD4				0.3224^{**}	
				(0.1287)	
RD5					0.3947^{***}
					(0.1522)
Size	-0.0009	-0.0019^{**}	-0.0022^{**}	-0.0030^{**}	-0.0032^{***}
	(0.0008)	(0.0008)	(0.0010)	(0.0012)	(0.0012)
Lev	0.0089	-0.0066^{**}	-0.0066^{*}	-0.0064	-0.0085^{*}
	(0.0114)	(0.0028)	(0.0039)	(0.0043)	(0.0043)
ROA	-1.5440	-2.5464^{*}	-1.2466	-0.3620	-1.7976
	(1.3132)	(1.3581)	(1.2550)	(1.2708)	(1.4874)
NPFA	0.0044	0.0853	0.2299^{*}	0.2215^{*}	0.1874
	(0.1203)	(0.1321)	(0.1214)	(0.1257)	(0.1265)
ROE	1.7063^{**}	2.1193^{**}	0.2067	0.2690	0.6345
	(0.7492)	(0.8986)	(0.6719)	(0.5957)	(0.8995)
PB	0.0024	0.0042^{***}	0.0046^{***}	0.0049^{***}	0.0001
	(0.0022)	(0.0015)	(0.0014)	(0.0013)	(0.0013)
_cons	-0.0196	-0.0310	-0.0098	-0.1346^{*}	-0.0474
	(0.0885)	(0.0751)	(0.0757)	(0.0701)	(0.0844)
N	276	228	179	138	112
r2	0.0407	0.1106	0.1256	0.2131	0.1814
F	1.1139	4.2051	2.6226	3.1386	2.5980