The effect that R&D has on company performance: comparative analysis based on listed companies of technique intensive industry in China and Japan

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Abstract

Nowadays, technique innovation is the precondition that companies, especially technology intensive companies, can survive and develop, when R&D investment, which affects company's operation performance, is a significant measure for companies to undertake technique innovation. However, the R&D progress goes with the characteristics of long term lasting, uncertain investment return, etc, and technique is always in upgrading and obsolescing. As a result, hysteresis may appear in the effect that R&D has on company performance, and the effect would become weaker, even disappear as time goes on. Referring to the innovation theory and the source-based theory, etc. this essay will study on the R&D investment by making use of the panel data of R&D investment of technology intensive companies. We will check the correlation between R&D investment and company performance, calculate the lag period and effect period of the correlation, and take an investment effect analysis with empirical method and comparative method on the technique innovation in China and Japan.

Key words: R&D, performance, lag period, effect period

1. Introduction

As we are living in an age when the science and technology keeps changing all the time, it is obvious that the ability of technique innovation be significant to companies. By doing R&D activities, the companies improve the technique level, bring efficient output and get better performance. A lot of empirical studies have prove the correlation between R&D level and company performance. However, the R&D activity comes with a long process and high risk exists for the return of the investment. These factors make R&D activity risky and make the intent of the company to rise the R&D investment limited. The grade of the risk is close linked with the macro economic situation and the government policy, so to a great degree, the effect that R&D expense has on company performance can reflect the economic environment. China and Japan, as two east Asia countries which both play a decisive role in the world, are no doubt the best objects to do a comparative analysis.

China is in a key period when the economic is experiencing a transition, and R&D activity is the source power to make the transition count. In recent years, the R&D expense in China has been keeping going up as the R&D scale extents, while the R&D information disclosure has been required better. However, the R&D intensity in China is still at a relatively low level, which tells that in China, the output effect caused by R&D activity is still weak. According to the data of the World Bank[1], in 2008, 1,199 of the every million population are engaged in R&D works in China, and the number can't even reach the level of the world average in 2005, less than that of Tunisia and Malta. And, the ratio of R&D expense to GDP is 1.47%[2], ranked 25th, behind the world average level 2.14%.

On the other hand, as a big country which has a same large power with China, Japan has a higher R&D level. According to the same data, in Japan, 5,189 of every million population work on R&D activities, 4.3 times of that of China. The ratio of R&D expense to GDP is 3.36%, ranked 4th in the world, just behind Israel, Finland and Sweden.

Huge numbers of studies have been done in this area, but few have focus on the degree of the correlation, the length of the lag period and the effect period and the same time, while comparison between China and Japan is even more rarely seen. To deal with this, this essay will work on the panel data of technique intensive companies in China and Japan from 2007-2011, look into every detail of the effect R&D expense has on the company performance, and do the comparative analysis.

The rest of this essay is arranged as bellow: the second part is the literature review, we will check the studies of former researchers and put forward our hypothesis; the third part works on the study design, and we will illustrate the choice of the model, sample and variables. The forth part is the empirical part and the last part gives the conclusion.

2. Literature review

2.1 The R&D expense and the company performance

The study of economics has proved that, the development of company, industry, even the state largely depends on the innovation strategy. According to endogenous growth theory, innovation is a key factor of the technical process, and both innovation and technical process have two sources: research and development (R&D) and foreign direct investment (FDI), and R&D is the more important one between the two, which is the source power of the innovation.

Schumpeter has referred that, in his famous innovation theory, managers make creative destruction, so that they can realize the reset of sources and form new competitive advantage. That will break the balance of the

[1] http://data.worldbank.org.cn/indicator/SP.POP.SCIE.RD.P6
[2] http://data.worldbank.org.cn/indicator/GB.XPD.RSDV.GD.ZS

market and they can get above-average return. So, technique innovation is the basic energy of the economic.

On the point of view of source-based theory, technique is the strategic asset of the company. By R&D investment, company improves the learning ability, obtain, assimilate and apply new knowledge of technique. This process helps the company transfer outer information into new product or service, and assists the company with constructing technical framework to realize technique level up. As a result, R&D is regarded as the key point for company to benefit in the competitive market, and R&D promotes the improvement and innovation of the production process and the product. In this way, R&D investment contributes on the company's profitability, and then improves the company performance.

Plenty of empirical studies have been done to prove the correlation between R&D expense and company performance. Laiqin Liang, Huanfeng Zhang(2005) has validate the correlation with 72 high technology companies as the sample; Hongwei Cheng(2006) extends the sample to 96 companies; and Zhong Li, Qin Zhou(2012) do the same work with a stochastic frontier model; Sharma(2012) gets the same conclusion with data of Indian pharmacy industry.

H1: R&D expense has a significant positive correlation on company performance.

2.2The lag period of the R&D activity

Up to now, there has been no unified definition for R&D output hysteresis in the academe. However, more and more researchers have been taking hysteresis into consideration when looking into the relationship between R&D investment and the economic effect. That is because when R&D activity is done, no technique product or economic benefit can be worked out immediately, for a time lagging exists. Hecheng Wang(2001)[3] divides the process between R&D investment and R&D effects into five parts: input, processing system, output, receiving system and outcomes. Among these, receiving system and outcomes are processes when the company benefits from scale production and marketing after the R&D output, so the real R&D process locates on the first three parts, that is, the process when R&D capital is invested on equipment, human source, circulating fund and when R&D staff finally gets the R&D output, like patent or product, after the segments of research, development and test under the background of special R&D organization and the support of the existing R&D resource. So it can be seen that the R&D activity has a considerable lag period, the R&D investment of current period can not affect the company performance.

When studying the effect that R&D expense has on company performance, some researchers has noticed the existing of the lag period. Xingang Zhao(2012) analyzes the panel data of 91 manufactory listed companies in 5 years with two-way fixed effect model, and concludes that the best lag period for Chinese listed company is two years; Laiqin Liang, Huanfeng Zhang(2005) also believe that it takes more than two years for R&D expense to affect company performance; Falk(2012) gets the same lag period with the data of Austria in 1995-2006.

H2: a lag period exists for the positive correlation between R&D expense and company performance.

2.3 The effect period of the R&D activities

The technical innovation brought by R&D comes with an obvious timeliness. The update and upgrading of technology makes old technique eliminated and lost its value, and the process of technical updating and upgrading is getting rapider nowadays. According to the labor value theory by Karl Marx, the value of commodity is decided by the social necessary labor time. By improving its technical level and thus reducing the social necessary labor time, company gains excess return. However, as the technical threshold opens, old technology is

[3] Hecheng Wang. (2001). the research on the correlation between R&D investment and company growth. Scientific management research, 13-16.

never a secret of one or two companies, thus, the social necessary labor time for the whole world will be shorter and company loses the ability to get excess return. The circle goes on and that is the process of technique innovation. So, the improvement of the company performance brought by R&D investment is limited in a period, and the effect will disappear after the period comes to an end.

Few researchers has specially focus on the effect period but some has mentioned it. Falk(2012) finds that as the time goes on, the effect brought by R&D expense will fade.

H3: an effect period exists for the positive correlation between R&D expense and company performance.

3. Research design

3.1 The choice of the sample

To choose the sample, first we have to define technique intensive industry. Dessyllas and Hughes divide technique intensive industry into 8 parts: chemical industry, business machine and computer equipment industry, electrical industry, transportation equipment industry, measure and control equipment industry, pharmaceutical manufacturing industry, communication industry and professional service industry[4]. Referring to their standard, after looking into the naics 2007 code, we define technique intensive industry to include the following 12 industries: 211 oil and gas extraction; 324 petroleum and coal products manufacturing; 325 chemical manufacturing(including pharmaceutical and medicine manufacturing); 333 machinery manufacturing; 334 computer and electronic product manufacturing; 335 electrical equipment, appliance, and component manufacturing; 336 transportation equipment manufacturing; 339 miscellaneous manufacturing; 517 telecommunications; 518 data processing, hosting and related services; 51913 internet publishing and broadcasting and web searching portals; 54 professional, scientific, and technical services.

On the other hand, on the time line, we choose data between 2007 and 2011 because in 2006 China put new accounting principle into effect and after that disclosure of R&D in China began to be gradually more comprehensive and the data is easier to get.

There's one more point that only listed companies are chosen because the data of unlisted company is hard to get.

3.2 The choice of the variables and the construction of the model

To evaluate the R&D level, we generally have two ways, one is the absolute number and the other is relative number. The former is got by using R&D directly or after taking the logarithm, while the latter is calculated by dividing operating revenue into R&D expense. Researchers who use the former idea includes Shail Pandit(2011), I Han(2011), etc. and Hongwei Cheng(2006), Laiqin Liang(2005), Wang(2011) etc. use the latter one. There're also researchers taking the both, like Xingang Zhao(2012). We think that using a relative number is better to match the relative numbers of our explained variable and control variables, so we will take the latter idea to evaluate R&D level.

And to evaluate company performance, most researchers would prefer ROE or Tobin's Q. To get the data more easily, we will use ROE.

At the same time, the following control variables are put into the model:

Lev, the asset-liability ratio of the company, to reflect the company's capital structure;

Size, the logarithm of the total asset of the company at the end of the period;

Grow, the growth rate of the operating revenue of the company, to reflect the growth phrase of the

[4] Dessyllas, P.,Hughes,A.. (2005). R&D and Patenting Activity and the Propensity to Acquire in High Technology Industries. Working Paper.

company;

Fii, the ratio calculated by dividing operating revenue into free cash flow of the company.

So, the model is finally set as follow:

$ROE_{it}=\alpha_0+\alpha_1 RD_{it-n}+\alpha_2 Lev_{it-n}+\alpha_3 Size_{it-n}+\alpha_4 Growth_{it-n}+\alpha_5 Fii_{it-n}+\eta_{it}$

And n is the lag period.

After the hausman test, no matter the data of China or Japan, the fixed effect model will be used.

3.3 The source of the data

All data comes from the BVD database. And we will eliminate the following observations:

Observations with a minus ROE;

Observations with a minus RD;

Observations with a minus Fii;

Observations with missing values or extreme values.

4. Empirical analysis

4.1 Descriptive statistics (refer to table 1 at the end of the essay)

From the table we can see that both China and Japan have a 3% assumably R&D level, while Japan is a bit higher. China has a higher max and a lower min than that of Japan, so it is smoother for Japan's R&D level.

4.2 Regression outcomes (refer to table 2 at the end of the essay)

The regression tells us:

In the current period, R&D has a negative effect on company performance. As we have mentioned, R&D activity is linked with risk and uncertainty, and would occupy large amount of capital, which will worsen the company performance. However, in the later period, a positive effect comes about for both the two countries. For China, the strong correlation appears in the t+2 period and in Japan the t+1 period, which explains that the best lag period for China is two years and for Japan is 1 year, and that is the same with former researcher's study.

So, H1 and H2 are supported by the empirical outcomes.

For China, there's no significant correlation for the R&D expense until the t+2 period, and in the t+3 period the correlation disappears. That is to say, the effect R&D expense has on company performance just lasts one year. For Japan, the effect period lasts one year too, for the t+1 period. We can see that as the time goes on, R&D stops having an effect on company performance, and that is because the technique is under innovation all the time, which makes old technology gradually useless.

So, H3 is supported by the empirical outcomes.

4.3 Comparative analysis

First we will look into the lag period. From the empirical outcomes we can see that Japan has a shorter lag period, which means if a Japanese company invests in R&D activities, it will take less time for the Japanese company to benefit from the investment, and there is more than that. As we have mentioned above, R&D is a long process that needs sustained investment, which means during a long period, a huge amount of cash and other capital will be occupied. On the other hand, cash is such an important item for company that without enough cash to use, the company may carry the risk to go bankrupt. And what's more, it is impossible for the company to succeed in every R&D activity, however, the R&D investment may be in vain and the company has to face the fact that they get nothing from one R&D investment and the cost is meaningless. So once the company

invests in the R&D activity, risk and uncertainty will come about at the same time, and the grade of the risk and uncertainty is decided by the length of the lag period. A shorter lag period means shorter capital chain, and a shorter capital chain means less risk to suffer. Simultaneously, a shorter lag period also means if the R&D activity comes in vain, the company can exit earlier, in case that the company does more useless work on it. So as a conclusion, Japanese companies suffer less risk and certainty than Chinese ones, they have a better environment for innovation, while Chinese companies have to worry if their R&D can bring about return ideally.

Then, the effect period is about to be discussed. Our empirical analysis tells us both China and Japan has an effect period of one year. As our time unit is year, an effect period of one year is really short. We think that the length of the effect period reflect the speed of technique innovation. The technique upgrading and updating comes faster, the effect period is shorter. So the one year effect period illustrates a frequent technique innovation for both China and Japan. The technique's quick being out of date can encourage the company to invest in R&D activity to ensure not to be dropped out in the technique competition, so an environment with a short effect period must be able to create an atmosphere that can encourage all companies to devote in technique innovation. However, everything has a limit. Though it can encourage companies to innovate, a too short effect period also tells companies that, they can benefit few from R&D activity. All companies would hope that their R&D outcomes can last longer so that they can benefit from it for a longer time. If the effect period is too short, companies will lost their interest, for maybe today the R&D outcome is worked out and tomorrow it is out of date. So on one hand, a short effect period encourages company to invest in R&D and on the other hand, if the period is too short, things turn over. Thus we get the conclusion, an ideal environment for innovation needs a suitable effect period, while China and Japan both have one.

5. Conclusion and advice

In the discussion above, we illustrate the positive correlation between R&D level and company performance, and does the comparative analysis. And some conclusions can be summarized.

(1)With a lag period, R&D expense has an obviously positive effect on company performance, and the effect does not last forever, but for one year, and after the period the effect disappears.

(2)China and Japan both have an effect period of one year, however, Japan has a shorter lag period, which tells us that the innovation environment in Japan is better.

And we will also give some advice, both to companies and to the government.

To companies:

(1) Pay more attention to R&D activities.

As we have proved that, R&D investment has a positive effect on company performance, companies would have reason to care about their R&D activities and advance their R&D level, and make use of R&D expense to improve the performance. Besides, more should be done like perfecting the construction of the R&D department and regulate the R&D process, which may be propitious to make R&D activities more efficient. What's more, as the effect period is short, losing attention on R&D may make companies falling behind is the technique competition.

(2) Be rational about R&D investment

The existence of lag period makes R&D activities risky, so when companies invest in R&D activities, the risk and uncertainty must be taken into consideration seriously. Though more R&D expense can bring better performance, companies should never be blind about R&D. Our advice is to carefully estimate the risk in the R&D investment, control the scale of the investment, in case that capital cannot be timely back or a failing of investment comes about. Chinese companies should be more careful for the longer lag period in China.

To the government:

(3)Improve the innovation environment

From the view of a country, China still has a low level of R&D, so there's a lot to do. With a lag period of two years, Chinese companies have to think twice before investing in R&D activities, which will weaken the passion and desire for them to innovate, and that is adverse for the country to improve its competitiveness. The government may introduce some macro policy to encourage the companies to pay more attention to R&D, like kinds of government subsidies, more and better financing platforms, and so on. Japan has a better environment, but there are still some problems to deal with. For example, R&D expense is used as a measure to smooth profit.[5]

Table 1 Descriptive statistics

	China	Japan
Observations	1619	2839
Mean	0.0306361	0.0347795
Median	0.023852	0.024413
Max	0.423604	0.3174596
Min	0.000002	0.0000198
Std. dev	0.0339057	0.0378897

Table 2 Regression outcomes

	T period		T+1 period		T+2 period		T+3 period	
	CN	JP	CN	JP	CN	JP	CN	JP
RD	-0.079 (-0.56)	-0.081 (-0.69)	0.113 (0.28)	0.488 (3.04)**	6.612[6] (4.65)**	0.007 (0.04)	-0.282 (-0.28)	-0.127 (0.60)
Lev	0.397 (15.69)**	0.182 (7.92)**	0.271 (3.17)**	0.227 (6.45)**	-0.090 (-0.83)	0.162 (4.02)**	0.172 (0.47)	-0.163 (-3.23)**
Size	-0.079 (-13.22)**	-0.049 (-8.00)**	-0.081 (-3.84)**	0.012 (1.14)	-0.091 (-2.64)*	-0.060 (-4.00)**	0.102 (0.70)	0.056 (2.77)**
Grow	-0.000 (-0.24)	0.058 (13.90)**	0.007 (1.65)	-0.010 (-1.62)	0.015 (0.84)	-0.052 (-7.66)**	0.091 (1.32)	0.020 (2.36)*
Fii	0.739 (15.33)**	1.706 (36.41)**	0.108 (0.65)	0.425 (7.29)**	-0.587 (-1.70)	-0.324 (-5.15)**	-0.633 (-1.21)	0.134 (1.58)
con	0.876 (10.90)**	0.547 (6.65)**	1.019 (3.64)**	-0.200 (-1.44)	1.192 (2.93)**	0.883 (4.49)**	-1.142 (-0.59)	-0.559 (2.13)*
F	184.79	385.43	10.77	19.32	6.98	32.94	0.75	9.38
Adj R^2	0.5480	0.4655	0.2763	0.0566	0.4481	0.1274	0.3194	0.0753
Obs	1619	2839	755	2235	157	1751	54	1197

[5] Mande Vivek&File Richard G.. (2000). Income Smoothing and Discretionary R&D Expenditures of Japanese Firms. Contemporary Accounting Research,263-303.

[6] This coefficient is extremely high and unreasonable. To test why such extreme value appears, we do another regression. In the model we use in the main body of this essay, we regard the year 2011 as the T period, and the T+2 period is the year 2009. Now we let the year 2010 to be T period and 2008 to be the T+2 period, do the regression with fixed effect model, and the coefficient show a largely lower result than that. So we think the extremely high coefficient is connected with the particular year 2009, when the financial crisis swept cross the whole world including Japan seriously but China wasn't affected so hardly.

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