

Empirical Research on the Relationship between the Subdivided Indicators of the Sustainable Development Rate and the Enterprise R&D Input¹

RECHERCHES EMPIRIQUES SUR LA RELATION ENTRE L'INDICATEUR SUBDIVISE DU RYTHME DU DEVELOPPEMENT DURABLE ET LA CONTRIBUTION DE R&D DES ENTREPRISES

Chen Haisheng² Ge Liang² Cao Xiaoli²

Abstract: This paper divided sustainable development rate into return on total assets, equity multiplier, retained earning ratio, and tested their relationships with the R&D input. By applying the cross-section regression method, it built up the regression model through the empirical research on 93 listed high-tech companies in electronic, medical, and new material industries, in which the influence of those three indicators on the R&D input was tested. The results implied that the coefficient of return on total assets, retained earnings ratio, and the equity multiplier was 0.101, 0.0018 and -0.007 respectively. Finally, this paper analyzed those coefficients and proposed the comprehensive solution for how to take rational financial action to promote the R&D input in different conditions.

Key words: Sustainable Development Rate, Return on total assets, Equity Multiplier, Retained Earning Ratio, R&D Intensity

Résumé: L'article présent divise le rythme du développement durable en rendement de l'actif total, multiplicateur de capitaux propres, ratio du rapport, et teste leur relation avec la contribution de R&D. En appliquant la méthode de régression en coupe transversable, il construit le modèle de régression à travers les recherches empiriques sur 93 entreprises cotées de haute technologie dans les domaines électronique et médical ainsi que l'industrie de nouveaux matériaux, dans lesquels l'influence de ces trois indicateurs sur la contribution de R&D ont été expérimentée. Les résultats impliquent que le coefficient de rendement de l'actif total, le ratio du rapport et le multiplicateur de capitaux propres sont respectivement 0.101, 0.0018 et -0.007. Finalement, l'acticle a analysé ces coefficients et proposé une solution synthétique favorable à la prise des politiques financières raisonnables afin de promouvoir la contribution de R&D dans de différentes conditions.

Mots-Clés: rythme du développement durable, rendement de l'actif total, multiplicateur de capitaux propres, ration du rapport, intensité de R&D

R&D input is the essential investment for enterprises implementing its sustainable development strategy. On the one hand, the strengthening in R&D input can keep the production and sales increasing sustainably, which is the feature of the firms' sustainable

development; On the other hand, the enterprises which are in its sustainable development stage, are likely to have the sufficient cash flow from their sales to support their high risked R&D investment. Facing the ever fiercer competition environment, enterprise should get

¹ This paper is the periodic achievement of the <The study on the issue of improving the independent innovation ability and the industry technology advancement > sponsored by the 2006 National Social Science Fund, 06BJY021, and the 2004 Guangdong Natural Science Fund, 0430013.

² Shool of Business and Administration, South China University of Technology, Guangdong, China.

* Received 30 December 2006 ; accepted 19 February 2007

into a benign circulation: higher sustainable development rate—more R&D input-- higher sustainable development rate....., which conforms to the enterprises long term development strategy.

Actually, the sustainable development speed is determined by the operation efficiency, the capital structure, and the dividend allocation. More concretely, it is the comprehensive effect of operation strategy, financial policy, and the retained earning allocation policy. This paper will try to find out the relationship between these three determinants of sustainable development rate and the R&D input.

LITERATURE REVIEW

Some researchers have studied the internal elements which affected the enterprises' R&D activity: Kletee (1996) studied the relationship among the R&D, enterprises performance and the economy scale, whose test sample were 804 manufacturers selected from 1989 to 1990 in Norway. He exposed the proportional relation between R&D and enterprises performance. Von Braun (1999) found out the "The Acceleration Trap" in R&D investment. Actually, the trap resulted in the high risk that R&D spends increased without the sales growth. It indicated the none-proportional connection between the R&D input and revenue growth.

Luo Pinliang (1998) studied the market structure and the R&D stimulation. By setting up the "Winner-not-take -all" R&D competition models, he found out the number of enterprises in industries was positively correlated with the R&D input. After learned about the relationship between the enterprises scale and R&D, Jin Lingdi and Chen Guohong (2001) concluded that the small enterprises started up its R&D at low successful probability than the medium and large enterprises. That is to say, the R&D starting-up probability generally increased with the expansion of the enterprises scale. However, the amount of R&D input went down after long upward trend with the scale increasing. So, there was an optimum scale in the enterprise's R&D activities. Fengfei (1995) classified the element affecting the enterprises R&D activities into enterprises scale, competition pressure, technology introduction, export direction, technology patent, etc. Gaomin (2004) explored the critical element of the technology innovation with the case study on the electronic industry. And the critical element included the market centralization, enterprises scale, property system and the import policy of the industry. Wang Xiaochun (2002) examined how the capital structure influenced the investment of the enterprises' innovation. And he concluded that the enterprise in high liability will be relatively cautious in the innovation investments. Wang Renfei(2005), after studied the internal elements of the R&D input among the top 100 Chinese electronic

and information enterprises, concluded that the enterprise scale and the profit rate were proportional to the R&D input °

To sum up, the recent relative research focused on exploring the relationships between R&D input and industrial elements, such as enterprise scale, competition pressure, technology import, export trend, technology patent. Their efforts helped us to realize that R&D input and technology innovation were affected by multiple elements. The policy maker should dig out those major elements and their influence before they designed the concreted policy. Financially, if those elements reflected on the financial indicators, it would not only promote the R&D efficiency, but also highlighted the interrelationship between these elements. What's more, the different financial policy would have different effect, positively or negatively on those industry factors. For example, the on total assets could reflect the capacity of economy growth. Consequently, we consider that it is necessary to have the factor analysis on R&D input in the financial perspective. These financial factors were selected from the achievement of Wang Xiaochun (2002), Wang Renfei (2005), who had divided the general indicator of the sustainable development rate into several subdivided indicators, in order to reflect the economy growth capacity and financial policy.

HYPOTHESIS

The sustainable development rate can be examined by the maximum rate of the enterprise sales growth in the condition that the stock equity relatively remains unchanged, that is, the current operation efficiency and the financial policy are maintained. As it is known that, the operation efficiency can be reflected on the turnover rate of total assets and the profit rate of sales while the financial policy is reflected on the debt ratio and the retained earning ratio. According to the financial management theory, the enterprise's growth, in the long term perspective, is constrained by the sustainable development rate, though the speed seems to be changeable. With respect to the source of funds, the enterprises' stable growth can be achieved when the current financial structure with its related financial risk matches the sales growth. On the one hand, the enterprises can finance enough cash to support the expansion of sale scale On the other hand, the sales growth can produce enough cash to reduce the financial risk. In that case, the growth rate will not consume the enterprises fortune, which we regard as the sustainable development rate. And the sustainable development rate is divided into three key subdivided indicators as illustrated in the equation below:

Sustainable development rate = equity multiplier× return on total assets× retained earning ratio / (1- equity

multiplier×return on total assets × retained earning ratio).....(1)

As can be seen from above equation, the sustainable development rate was determined by the three financial indicators, namely, return on total assets, retained earnings ratio, and equity multiplier. The indicator of return on total assets reflects the efficiency and capacity of assets utilization. The retained earnings ratio and the equity multiplier in some extent represent the financial policy decision. The former indicates management attitude toward dividend allocation policy, and the latter shows the management decision on financial leverage which relates to the financial risk. Actually, these two indicators are managers' decision between reward and risk. Therefore, the ability to gain profit and the extent to bear the risk has great effects on enterprise's sustainable development speed.

Based on these three key indicators, we established the multi-analysed regression model to expose their relationship with R&D input.

Generally speaking, R&D investment requires large funds and extra profits to support because of its large economy scale. As a result, the stronger earning capacity is, the more R&D inputs are. As the return of total assets is the indicator for the firm's earning capacity, so the indicator in higher level may imply the stronger ability to invest in R&D. According to the old Chinese Accounting Standards (withdrawn in 2007), however, the R&D spends could not be capitalized which made the annual profit decrease and had a negative effect on the annual total return on total assets. In that case, it was hard to analyze the potential relationship between them. Besides, as the profit earned today may not put into R&D immediately, therefore, this paper examined the influence of total return on total assets on R&D input by applying the data in last one or two year. And the first hypothesis is as below:

Hypothesis1: The return on total assets in recent years (1 or 2 year before) is proportional with the R&D input this year. That is, the higher return in the past will bring about larger R&D input.

According to the former theory research and empirical studies, the enterprises with lower leverage level would be more active in R&D investment. The reason is that: the enterprises with high liability ratio have already burdened the high financial risk. As the R&D investment is considered to be a "gamble" for its high risk character, these enterprises tend to avoid the double risk and take a rather prudent policy to the innovation investment. Maybe they have to anticipate the gamble, but the internal finance or equity finance would be more favorable. However, the former way may be limited to R&D input, while the latter would be

time-consuming. Moreover, if they want to finance from their creditors, they may be required to pay higher interest to compensate the high risk caused by the "gamble". So the enterprises with high leverage level won't be active in R&D input. Here we have the second hypothesis:

Hypothesis2: the equity multiplier is assumed to have negative effect on R&D input intensity. That is, the enterprises with smaller equity multiplier are likely to have more R&D input.

The retained earnings indicator reflects the financial policy. The enterprises can try to change the dividend allocation policy to cut down the dividend and to increase the retained earnings ratio when they predict that external finance might be difficult. Here we have the third hypothesis:

Hypothesis3: the retained earnings ration is proportional to the enterprise R&D input intensity of next year. That is, enterprises with higher retained earning ratio are assumed to have larger R&D investment.

TEST AND RESULTS

As it had been discussed, the retained earning ratio reflected the dividend policy and the internal finance to R&D in the next year, so the retained earning ratio was the data of 2004, when we analyzed the R&D input intensity of 2005. And the data of return on total assets was that of 2003, while the equity multiplier was the data of 2005. Regarding the abnormality of the ST listed companies; our analysis would exclude those companies. All the analyses were operated by SPSSV13.0 with the original data of 93 listed companies from 2003 to 2005.

Based on above analysis, we built up the regression model below:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_i$$

X_1 represented the variable of the equity multiplier, and X_2 was assumed to be variable of return on total assets (the first test using the data of 2004, while the second test using that of 2003). X_3 was the variable of retained earnings ratio. Y was the dependent variable of R&D input intensity.

Besides, the R&D intensity of 2005= (total amount of R&D funds in 2005) ÷ (sales revenue of 2005)

The result of the primary regression model is as below:

Table 1: Model Summary (b,c) of the first regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.426(a)	.182	.154	.14736

a Predictors: (Constant), return on total assets 2004 , retained earnings ratio2004 , equity multiplier 2005

b Dependent Variable: R&D intensity 2005

c Weighted Least Squares Regression - Weighted by wls04

Table 2: Analysis of variance of the first regression

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.429	3	.143	6.586	.000(a)
	Residual	1.933	89	.022		
	Total	2.362	92			

a Predictors: (Constant), return on total assets 2004 , retained earnings ratio 2004 , equity multiplier 2005

b Dependent Variable: R&D intensity 2005

c Weighted Least Squares Regression - Weighted by wls04

Table 3: The regression coefficient analysis of the first regression

Coefficients (a, b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.029	.005		5.854	.000		
	Retained earnings ratio 04	.001	.001	.136	1.352	.180	.903	1.107
	Equity multiplier 05	-.006	.002	-.453	-3.881	.000	.674	1.483
	return on total assets 04	-.009	.037	-.027	-.241	.810	.716	1.397

a Dependent Variable: R&D intensity 2005

b Weighted Least Squares Regression - Weighted by wls04

As could be seen from the above analysis, the return on total assets of 2004 and the retained earnings of 2004 didn't pass the T test in 95% confidence. Generally, the regression equation can be rebuilt by removing some insignificant variation. However, because this paper

aimed to examine the influences of these three variations on the R&D intensity, we used the return on total assets of 2003 in place that of 2004, the result of the retest with SPSS linear regression is below.

Table 4: Model Summary of the second regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.650(a)	.423	.404	.15390

a Predictors: (Constant), return on total assets 2003 , equity multiplier 2005 , retained earnings ratio 2004

Table 5: the variance analysis of the second regression

ANOVA (b, c)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.546	3	.515	21.756	.000(a)
Residual	2.108	89	.024		
Total	3.654	92			

a Predictors: (Constant), return on total assets 2003 , equity multiplier 2005 , retained earnings ratio 2004

b Dependent Variable: R&D intensity 2005

c Weighted Least Squares Regression - Weighted by wls

Table 6: The regression coefficient analysis of the second regression (a,b)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	.027	.003		10.801	.000		
Equity Multiplier05	-.007	.001	-.479	-5.718	.000	.923	1.084
Retained earnings ratio 04	.002	.001	.190	2.118	.037	.807	1.239
return on total assets 03	.101	.029	.310	3.468	.001	.809	1.236

a Dependent Variable: R&D intensity 2005

b Weighted Least Squares Regression - Weighted by wls

Compared with these two regressions tests, we have learned that the significance has been greatly improved when applying the return on total assets of 2003, which represented the earning capacity happened two year earlier than the R&D input in 2005. Particularly, the linear relationship between independent variables and dependent variables was significant. The equity multiplier of 2005, retained earnings ratio of 2004, and return on total assets of 2003 have passed the T test in the 95% confidence, which implied that the three variables have great influence on the dependent variable, the R&D intensity of 2005. AS the tolerance and the VIF of these three variances were all around 1, it indicated the weakness of the multicollinearity.

Then we can get the new regression model:

$$Y = 0.027 - 0.007X_1 + 0.101X_2 + 0.0018X_3$$

X_1, X_2, X_3 represents the equity multiplier, return on total assets , and the retained earnings ratio respectively, while the Y is the dependent variable of the R&D input intensity. And the three independent variances cannot use the data of the same year. The equity multiplier can use the data of the test year, while the return on total assets should use the data in two year before the test year, and the retained earnings ratio should select the data one year before the test year.

CONCLUSION AND SUGGESTION

In the first regression test: the proportional relationship between the return earnings ratio of 2004 and R&D input intensity of 2005 could not be accepted (Sig. =0.81>0.05, Table3), we believed that it resulted in the delay of earning capacity turning to R&D input capacity. Concretely, the return on total assets may not always return in cash. However, the none-cash profits can't be invested in R&D. Accordingly, the cash profit to invest in R&D requires the accumulation period, different industry requires different duration of the accumulation, such as the IT industry cash turnover generally is higher than that of medical industry. What's more, each enterprise has its investment strategy and plan. Many of them take time to wait for the opportunity and decide where and how to invest rather than investing as soon as receiving the cash. So there is a lag between return on total assets and R&D input, and it is difficult to be estimated.

In the second regression test those three variances had passed the 5% significance test. And the regression result provided support for the three hypothesizes. First, the coefficient of return on total asset was 0.101, which indicated that this rate grew by 1% this year may bring about the increase of R&D intensity by 0.101% two

years earlier. That is to say, the earning capability has the positive but delayed effect on R&D intensity.

Second, the coefficient of equity multiplier coefficient was negative (-0.007) which indicated the inverse relationship between equity multiplier and R&D intensity, as the second hypothesis assumed. According to the result, when the equity multiplier increases by 1, the current R&D input intensity will decrease by 0.007.

Third, the coefficient of retained earnings ratio was positive (0.0018), which indicated the higher retained earnings ratio was, the more R&D input would be made. And the R&D input will increase by 0.0018% as the retained earnings ratio increased by 1% last year.

As it is noticed, all of these three coefficients are rather small. That is because the R&D input of the listed companies is relatively small when compared to their revenue, which resulted in the small R&D intensity.

What we can learn from above analysis is that the improvement of operation efficiency, the capital structure and the retained earning allocation policy will promote the R&D input intensity. Different financial policy will change the result of subdivision indicators of the sustainable development rate, and then the effect will pass on the R&D input intensity. Actually, different enterprises have different innovation platforms, economic strengths and technology manpower, which are the key factors influencing their decision on financial policy.

Below, we chose “the return on total assets level of the enterprise in its industry” and “whether the cash is enough”, as the main consideration to the financial policy decision. The former reflected the comprehensive strength of the enterprises while the latter indicated the available input; we set up coordinate combined with these two factors and formed the four quadrants so as to give consideration to every condition.

1st. The first quadrant: The enterprises are in the condition of high return on total assets and sufficient cash flow. These enterprises can take the differentiation strategy and take up with the technology innovation. R&D investment is supported by internal financing and the equity financing. And with the high earning capacity and adequate cash flow, these enterprises can cut down the dividend allocation to save the retained earning for R&D investment, as well as keeping the entity multiplier in low level to deal with the high R&D risk. Once these financial policies are implemented, the R&D investment can have stable and strong support. However, these enterprises also need to pay attention to the market perform of their new products. According to the foreign statistics, the relative minority of top patents or new enterprises have taken the

majority of the all innovation and invention value. For example, F.M.Scherer and his co-workers had a test in which some examples were selected for tracking their marketing performance (Baruch Lev. 2003). The examples included some German patents, some American patent series authorized by seven universities, as well as several new corporations in USA. The conclusion of the test is that a majority of value generated from innovation has been occupied by the minority of the patents and firms. The top 10 patents have taken up 81% to 93% of the total value of all the patents. It means that most of the patents are worthless. Therefore the investments on the patents have become a loss.

2nd. The fourth quadrant: The enterprises make no R&D input since they are at the lower level of return on total assets in their industry and lack of cash.

3rd. The second quadrant: The enterprises are at the middle or high level of return on total assets in their industry but suffered by the insufficient cash. Therefore, they can take the low-cost strategy and choose the low-risked or none-risked R&D, such as imitation and absorption. Regarding the lack of cash, the equity multiplier should remain unchanged or set to be 1. And it is not necessary to increase the retained earning since the enterprise is insufficient in cash flow. What they need to do is to focus on the control of the operation cash, such as shortening the accounts receivable and the inventory cycle, as well as delaying the accounts payable cycle. These those financial policies can relieve the temporary shortage in R&D funds and then help to increase the R&D input step by step. Otherwise, if the enterprise put a large amount money in R&D project ignoring the consideration of insufficient cash, it will be trapped by R&D risk.

4th. The third quadrant: the return on total assets of the enterprises is at the middle or low level of their industry. Fortunately, they have certain accumulation of cash and the short-term financing channel is smooth. In this condition, enterprises should still choose the low-cost strategy and select the R&D project carefully, the lower risked projects still be more favorable. As they have sufficient cash flow, the equity multiplier can be larger than 1. However, it should be no larger than the average level of those enterprises with no R&D input in the industry. Besides, these enterprises need to increase retained earning and pay attention to the cost control and the development of new products which are lower energy consume when produced. In a word, they should combine the financial policy and operation policy together to keep their R&D activities in the healthy condition.

REFERENCES

- Liu Li. Enterprise R&D investment influence factor: Based on resources view theoretical analysis. *Chinese science and technology forum*, 2003, 75 - 78.
- Feng Fei. Several fundamental influence factor of R&D activity in enterprise technological innovation. *Chinese soft sciences*, 1995, 10: 120 - 124.
- Luo Pinliang. The market result and the R&D drives. *The scientific research manages*, 1998, 2: 33-37.
- Jin Lindi, Chen Guohong. The Positive Study on the Relationship between Enterprise Scale and R&D. *The scientific research manages*, 2001, 1: 51-57.
- Gao Min. Empirical Research on the electronic industry technological innovation influence factor . *Economical latitude and longitude*, 2004, 2: 75 - 78.
- Wang Xiaochun. Capital-structural condition of firm's decision on innovative investment. *China industry economy*, 2002, 10: 89 - 95.
- Wang Renfei. The internal determinants of firm R&D expenditures ——evidence from top 100 companies of Chinese electronic & information industry. *Scientific research*, 2005, 2: 225—231.
- Chen Haisheng. *The study on R&D financial control*. Tian Jin: academy of social science publishing house, 2003.
- Baruch Lev. *Intangible asset——management, measures and submits a report*. Bei Jing: Chinese labor Social security Publishing house, 2003.
- Klette. R&D, scope economies, plant performance, *The RAND Journal of Economics*, Vol.27, No.3, Autumn 1996, pp.502-522.
- Fishman and Bob. The Size of Firms and R&D Investment, *International Economic Review*, 1999, Vol.40, No.4, November.

THE AUTHORS

Chen Haisheng, Ge Liang, Cao Xiaoli, Shool of Business and Administration, South China University of Technology, Guangdong, 510640, P.R. of China.

E-mail: haishengchen@163.com