

Study on Technological Innovation Influencing

Factors of Sci-tech Enterprises in Ningbo

Jianchun Li ^{1, a}, Chunzhao Liu ^{1, b}, Weichao Yang ^{1, c}

1. Ningbo Polytechnic, Ningbo 315800, China;

^aemail:729152065@qq.com

^bemail:lcz9969@126.com

^cemail:48599056@qq.com

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Abstract: By investigative research and field surveys on sci-tech enterprises in Ningbo, this paper focuses on analysis of restricted factors of independent innovations of sci-tech enterprises based on case examples. Method of a constitutive SEM (structural equation model) is applied, examining effects of these factors. In the end, suggestions on validity of independent innovation of domestic sci-tech enterprises are given.

Introduction

Referring to the strategic core of China of 'Encouraging a Technological Innovative Nation', as well as that of Zhejiang Provincial Party Committee, Ningbo Municipal Party Committee has been highly valuing the abilities of enterprises developing technological innovations these years. Thus, on top of it, this is to better boost the city's economy, according to the nation's strategy of 'Six Linkage' to 'Six Rises of Economy'. In Feb 2006, Ningbo Municipal Party Committee and Ningbo Government held a convention of 'Developing a City of Technological Innovation'. And this ended up with a public document of 'How Ningbo Develops as a City of Technological Innovation'. Later in 25 Jul 2007, Ningbo Municipal Party Committee and Ningbo Government held another convention on this topic, coming up with public documents of 'Suggestions of How Ningbo Develops as a City of Technological Innovation Further on', 'Suggestions of Rating Ningbo Developing as a City of Technological Innovation' and some detailed policies assorted. For Ningbo transiting its economy structure, it is the key work of government and society to encourage technological innovation especially that of enterprises.

By the year of 2010, there are 615 high-tech innovative enterprises and 142 municipal-level sci-tech enterprises in Ningbo. According to investigation of such high-tech innovative enterprises, by 2009, there are 426 enterprises whose new high-tech products weigh a proportion of 54.87% of total sales, which is much higher than the city's average of 15.42%. In the year of 2009, according to the statistical standards of 2006, the city's overall high-tech product output valued RMB 132.3 billion, increased by 14.45%. As a result, eight national industry park have been established, including Ningbo High-Tech Material Industry Park, Ningbo High-Tech New Energy and Energy-Saving Lighting Industry Park, Beilun Injection Machinery Industry Park, Yinzhou New Metal Industry Park and so on.

The author's research study focuses on high-tech and sci-tech enterprises, whose main operation relies on new technology development, technology consultancy, technology trading and services, as well as sci-tech products R&D and production. However these high-tech and sci-tech enterprises do not include enterprises and organisations only participating sales of such products. Detailed state level, provincial level and municipal level high-tech enterprises recognition standards are included in the articles of 'Recognition Management of Ningbo High-Tech Enterprises' and 'Boundary Explanation of High-Tech Enterprises' [1].

Analysis of Factors and Evidences of Independent Innovative Sci-Tech Enterprises

i). Ground Hypotheses

On the basis of qualitative analysis of research articles of related enterprises [2~8] , the author propose the ground hypotheses of this study as following.

1. Factors NOT in the structure modeling: time of establishment and independent innovation of sci-tech enterprises, scale of enterprises, and lifetime of their products.

2. Factors in the structure modeling: independent innovation of sci-tech enterprises, market competition and risk, consciousness of innovation, R&D ability, culture of enterprises, spirit of entrepreneurs, social assets of enterprises, market legislations and market demands.

ii). Research and Analysis of Surveys

1. Obtaining and Basis of Samples

According to the practical situation of Ningbo sci-tech enterprises and their industrial distribution, the author picks 15 national-level high-tech enterprises, 95 provincial-level high-tech enterprises and 30 municipal-level high-tech enterprises all within Ningbo, as the research objects. These samples have covered industries of mechatronics, high-tech materials, IT and electronics, pharmaceuticals, new energy and productive energy saving.

2. Design of Survey

To raise the feasibility and validity of research investigation, the sample enterprises are maintained in the area of Ningbo including Beilun District, High-Tech Park District, Zhenhai District. There are in total 150 surveys distributed and 135 surveys retrieved , among which 115 are recognised as effective, meeting the sample size requirement.

3. Normal Distributive Test with Variables

By research study of Mardia (1985), strictly saying, skewness and kurtosis of varibales in a normal distribution should locate among +2 and -2. The results of objection from the software of SPSS11.0 are illustrated as following (Table 1).

Index	minimum	maximum	Skew	kurtosis
DEMAND	7	12	-0.494	0.685
SOCIEC	21	95	-0.275	0.689
CULTUR	4	32	-0.539	0.954
STUDY	5	26	-0.247	-0.310
TECHSC	8	101	16.253	184.213
ENTROP	5	23	-2.532	0.851
TECHSC	4	31	-0.521	0.432
RISK	1	30	0.358	0.307
MACROP	4	24	0.201	0.732
COMPET	6	46	0.254	-0.451
TECHIN	6	31	-0.018	-0.367

Table 1: Various Influencing Factors

In Table 1, except of a slightly higher kurtosis of technological research ability, the others are within a normal range between +2 and -2, meeting the request of analysis by displaying a normal distribution.

4. Assessment of Fit Statistical Modeling

The statistical modeling of this research study applies a maximum intended method. After calculation and adjustment of this modeling, the responding maximum likelihood indexes are shown in Table 2.

fit index	readystate
root mean square error of approximation	0.043
comparative fit index	0.972
non-normed fit index	0.958

Table 2: Fitness Assessment of Statistical Model

From the output indexes, the maximum intended method shows an effective maximum likelihood of reality. Therefore this responding maximum likelihood can be well accepted.

5. Analysis of Results and Verification of Hypotheses

By applying an SEM method, this research has conducted a quantitative analysis of factors of enterprises independent innovations, which found out the effect of these factors on the magnitude of enterprises independent innovations. The research indicates that, the significance of these factors, by a decreasing sequence of influencing magnitude on enterprises independent innovations, are R&D investment, spirit of entrepreneurs, enterprise's social assets, consciousness of innovation, government legislations, market competition, culture of enterprise, current technology level, market demand and market risk.

Meanwhile, the following conclusions can be drawn. Enterprises' independent innovations are not related to the time span since such enterprises were established. Enterprises' independent innovations have a positive correlation with scale of enterprises, lifetime of products, market competition, consciousness of innovation, culture of enterprise, enterprise's social assets, government legislations and market demand. They also have a strong positive correlation with R&D investment and spirit of entrepreneurs. On the other hand, enterprises' independent innovations have a weak correlation with enterprises' current technology level and market risk.

Conclusions

i). Government Perspective

1. Market System Cultivation and Completion

The government should optimise the external competitive environment for enterprises by switching its managerial function from controlling management to servicing management, and by lessening straight interference on enterprises, leaving the market to distribute resources spontaneously. Meanwhile, the government should actively cultivate a perfectly competing market, develop a unified, open and ordered capital market, labour market and technology market facilitating a optimised resource distribution. This will further induce enterprises' assets reorganisation and labour flow.

2. Legislation Completion of Developing Independent Innovations of Sci-Tech Enterprises

First of all, the government needs to increase investment on independent innovations of enterprises, by conducting independent innovation related policies in the article of 'Suggestions of How Ningbo Develops as a City of Technological Innovation'. This will end up with a completed technology investing mechanism of 'Technology first applies, government finance guides and public finance supports'. Second of all, the government needs to develop its financial services for middle or small scale independent innovative enterprises, by conducting the article 'Recognition Management of Ningbo High-Tech Enterprises'. At the mean time, the government should also actively develop a financial mechanism for small independent innovative enterprises by encouraging them to impawn their patents. Lastly, the government should alter the legislation of income tax preferences, by switching the preferential focus from the lower end the industry chain to the higher end. So that independent innovative enterprises can accelerate their depreciation of fixed assets to sooner achieve a cost-recovery point and in the end, to reduce the risk of independent innovation. The government should eventually set up a platform of quantitative measurement and evaluation of independent innovative sci-tech enterprises.

3. Raising the Magnitude of Intellectual Property Protection

The government should accelerate the progress of 'Strategic Outline of Ningbo Intellectual Property 2009 to 2020', hence to complete the mechanism of intellectual property protection and to

enhance ability of enterprises to develop, apply and protect such intellectual properties. The government should optimise related policies and legislations, including commercial secrets protection, antitrust management policies and so on. The government should also establish a scientific and feasibility performance appraisal system, from a scientific development perspective, to facilitate enterprises' independent innovations, as well as to encourage them to raise their intellectual properties management.

4. Establishment of Public Service Platform of Independent Innovation

The government should build a public technology service platform to evaluate independent innovation of enterprises. Such platform aims to facilitate enterprises independent innovation, instead of direct profit or developing new profit point. The influence and effects of such platform should provide real-time, full-scale and direct-viewing independent innovation of its servicing enterprises. Therefore a scientific and systemic productivity evaluation system of this platform must be set up. It is hence recommended to apply the vector machine to accomplish such evaluation, and to build an overall satisfactory index system. These will eventually help related theoretical and means research and commenting modeling. Thus by further scientific analysis, they will point correct ways of innovation, find out optimisation methods, as well as indicating potential problems of platform itself.

5. Development of Venture Capital System and Its Operating Mechanism

First of all, a municipal-level venture capital parent fund should be established. This may partially come from municipal-level special budgetary subsidies, or partially from expense on technological industry development from the central government. One or several such parent fund with different functions can be established. The government should meanwhile encourage non-governmental capital investments on commercialisation of technological research findings, by the principles of 'Government inducing, market participating, specialist experts managing and operations standardising'. Second of all, the government should consider tax reducing policies on investors and venture capital organisations who especially invest on commercialisation of technological research findings. In the current situation, venture capitals, as general taxpayers, have to contribute a considerable amount of income tax, thus reducing their investing interests. Third of all, the government needs to provide more ways of venture capital exit, in order to reduce negative influences on commercialisation investment of technological research findings from such exit mechanism. There are basically two ways. The government should actively establish the GEM (Growth Enterprise Market) for middle and small technological innovative enterprises. On the other hand, a platform of middle and small technological innovative enterprises' share trading should be established, in order that a multiple-level capital market with original capital exits can be built.

6. Cultivation and Standardisation of Industry-University-Research Alliance

The government plays the planning, organising, coordinating and servicing role in an industry-university-research alliance. The establishment and development of an industry-university-research alliance is an extensive systemic project, which relate to profit of multi-level government, R&D organisations, universities, intermediary agents, production enterprises and so on. Therefore as the planer an organiser of this alliance, the government needs to coordinate among different subjects and integrate resources at each stage and connection. By establishing an effective profit distribution mechanism, all resources can be productively dispensed, hence to reduce overall investment, benefitting all allied subjects on both economic and social perspectives [9].

ii). Enterprise Perspective

1. Enhancing Enterprises' Strategic Management

Technological enterprises should focus on innovation based on prophetic vision, in order to search for effective ways to response future market demand. Such enterprises need to look for innovations based on their current technology level, following their strategic development plans, so that to build advantages in future market competition. Instead of decision-making on experience, and strategy despise and tactic valuing, enterprises need to make strategic plans by creating and protecting intellectual properties, establishing internal managerial system. This will eventually make the platform and basis for enterprises' independent innovation.

2. Reformation of Enterprise Organisation

A flattening and networking organisation tree benefits lateral communications, mutual trust and cooperation among employees. It benefits knowledge sharing among employees in a technological enterprise, in order to establish a strong and structural organisation base for enterprise's independent innovation. Normally, a customer-oriented operational organisation can faster and more productively deliver original thoughts to market as commercialised products [10]. For linking the market demand and enterprise's own technology supply, it becomes necessary to keep reforming organisation structure. Technological enterprises finally aim to flatten their organisation structure to customers, simplify bureaucratic hierarchy within, so that to facilitate commercialisation of innovations.

3. Building Enterprises' Culture of Innovation

All technological enterprises need actively to build a company culture that benefits technological innovations. Such culture can significantly benefits to bring up innovative employees and competitive innovations. All stages of enterprise's independent innovation are based on the innovation of enterprise's culture itself. This is not only logically consequential, but also historically. An innovative company culture can best stimulate innovative ideas and elements, benefiting occurrence of employees' creativity and innovative activities. Such culture will as well encourage enterprises to absorb new elements, adapting new environment, developing new markets and fulfilling customers' new demands.

4. Enhancing Management of Independent Innovation

First, enterprises need to establish standards of independent innovation management, which provide a strong basis for seeking new innovational managerial methods. This benefits enterprises in the new era on fulfilling new market demands and responding to new market competition. Second, enterprises need to focus on building a mechanism of managing independent innovations, by starting from examined technology development projects, which profits themselves on new innovational directions, as well as to raise enthusiasm of technical employees for innovation, and finally benefits enterprises in the long term. Third, enterprises must set up a 'people-oriented' independent innovation managerial flow path. This should actively create an innovational environment that unleashes employees' innovation abilities.

5. Increase Investment on R&D

In these years, technological enterprises in Ningbo have been inputting an significantly increasing investment on R&D. However the investment is weighing a decreasing proportion of sales. The problem is that enterprises usually focus on short-term profit from such investment, instead of long-term profit and relationship gain. Technological enterprises need to take full advantages from the articles of 'Managerial Methods of Innovation Funds of Technological Small and Mid-Scale Enterprises', 'Implementation Methods of Ningbo R&D Funding Plans', 'Provisionary Methods of Ningbo Funding Management of Intellectual Properties', 'Managerial Methods of Ningbo Technological Projects Plans' and etc. These articles encourage enterprises to input more on their R&D, so that to facilitate their independent innovational activities.

6. Taking Qualified Personnel Strategy as Advantages of Enterprise Independent Innovation

First of all, enterprises need to optimise their own incentive system. This plays a significant role for enterprises to attract high-tech R&D employees and to incentivise them. Such incentive system needs to be based and optimised on characteristics of enterprises' R&D employees. The material and spiritual encouragement from this system should also be offered more to innovative employees. Second of all, a technological enterprise should optimise the value and effectiveness of internal training by analysing the demands of innovative employees, combining them to those of enterprise's strategic development, and focusing on versatile means of training [11]. In addition, technological enterprises need to work on employing more innovative personnel. Since innovations of an enterprise are based on knowledge of all employees, those with strong innovative willing and discovering spirit benefit innovations of the enterprise itself.

Limitations and Future Work of Research

By limitations of subjective and objective conditions, this research study has certain drawbacks detailed as following.

1. Limited size of samples of empirical study: by limitation of objective conditions such as funds and timescale, the number of samples in this research study is 115. Although this size exceeds the requirement of 100 proposed by Boomsma (1992), he also claimed that a larger sample size of over 200 would outcome a more reliable and repeatable analysis result.

2. The research study fails to obtain time sequence data from surveyed sci-tech enterprises. Hence it fails to discover the dynamic trend of enterprises' independent innovations.

3. The data obtained from the surveys of this research study is considerably affected by personal attitude and cognitive level. They further affect the reliability and authenticity of research.

As a result, potential future work is listed as following.

1. The research sample size needs to be greatly extended, thus to enhance the reliability of research study results.

2. Introduction of time sequence data needs to be done in empirical study, so a dynamic trend of enterprises' independent innovations can be discovered and analysed.

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