ON EVALUATION FOR INNOVATION BY ALL DIMENSIONS

[1]LUO Guicheng, [2]Wu Jie

[1]Xi Jinping Thoughts Research Office, Bengbu University, Bengbu, China

[2]Science and Research Department, Bengbu University, Bengbu, China, 233030

ABSTRACT

When undergoing an analysis upon risks, costs and revenues of an innovation, we have many dimensions, the first, time process dimension, e.g. (1) risks, costs at the stage of pre-innovation, (2) risks, costs during the process of an innovation, (3) risks, costs and revenues after the innovation. The second, space dimension, e.g. internal risks, costs of an innovation, external risks, costs of an innovation. The third is the original degree of an innovation, e.g. analyzing risks, costs and revenues of an independent innovation, a mimic innovation and a cooperated innovation respectively. We can also opt for an economics perspective for our analysis, e.g. direct costs, revenues of the innovation in short term, and, indirect costs, revenues of the innovation in long term. The appraisal for a soft innovation, such as thoughts innovation, management innovation, institution innovation, could mean more difficulties. For a significant innovation, it is necessary to evaluate its risks, costs and revenues with all dimensions systematically. Any innovation, could involve learning costs as well as risk control costs to different degree.

Innovations of the paper, (1) the concept as well as implication for all dimension evaluation, (2) how to run all dimension evaluation. Methods of the paper, (1) literature research, (2) case study.

Keywords: All dimensions, Innovation evaluation, Double Innovation Education

1. INTRODUCTION

The 5th Plenary Session of the 18th CPC Central Committee pointed out: "Persist in innovative development, put innovation at the core of national overall development, constantly push forward theoretical innovation, institutional innovation, scientific and technological innovation, cultural innovation, etc., let innovation run through all the work of Party and country, let innovation prevail in the whole society. " Xi Jinping proposed embroidery spirit, Li Keqiang encouraged craftsman spirit. China has implemented the "Mass Entrepreneurship, Mass

Innovation" national policy and "Made in China 2025". Chinese Ministry of Education also began a program 'Transforming development for innovation and entrepreneurship education'. Innovation is the soul of national progress and the inexhaustible source of a country's prosperity. It is of great practical significance to initiate the reform of innovation & entrepreneurship education in local colleges of applied science & technology. In the development of education, we should enforce the integration of innovative entrepreneurial concepts, improve the training mechanism of innovation and entrepreneurship, cultivating pupil's innovative spirit and entrepreneurial ability. The research holds that the effectiveness of innovation & entrepreneurship could be only guaranteed by introducing all dimension evaluation, by introducing individual innovation & entrepreneurship management, also evaluating risks, costs, benefits of innovative entrepreneurial activities from different dimensions.

2. RISKS OF INNOVATION & ENTREPRENEURSHIP

2.1 Risk Type of innovation

Risk generally refers to future negative uncertainty. Wikipedia citing the Oxford dictionaries, the word "risk" originated from French risqué in 1621, spelled 'risk' in English in1655, which means the possibility of exposure to loss, injury and other adverse circumstances, or the situation and chance to get involved in those possibilities.

Xie Kefan, Li Xiaoqun (1996) sorted the process of technological innovation into three stages: technology stage, production stage and market stage. According to these three stages, the risk of technological innovation can be summed up as technological risk, production risk and market risk.

Ana M. Fernandes, Caroline Paunov (2015) made a similar research in which innovation brings several dimensions of risk to manufacturers. The first dimension of risk, derived from portfolio theory in finance, refers to the risk of diversified investment associated with a large source of income for manufacturers. The new product account for a large share of the manufacturer's income, compared with existing products, its success, sustainability is highly uncertain. The second dimension of risk denotes the technical difficulty risk that manufacturers confront, especially the introduction of new products exceeds the expertise of manufacturers. The third dimension of risk refers to market challenges. A strong marketing strategy is required upon manufacturers facing a competitive environment when they bring new products to the market successfully. Their research results unveil that, in Chile, multi-product enterprises, innovators are 29% less likely to die than non-innovators. While for single-product enterprises, innovators are 40% more likely to die than non-innovators. Only those prudent innovators guaranteeing a diversified source of income, introducing new products on a small scale, could significantly low

down the market exit rate.

From an investigation upon the origin, there may also be psychological risk and moral hazard. Bruno Biais, Jean-Charles Rochet, PaulWoolley's (2015) conclusions, previous successes could also reduce vigilance against future risks: (a social system symmetrical with agent information) the standard of risk prevention would be reduced after success, as starts from the acceleration of growth in the field of innovation. After a period of sustained performance as well as confidence growth, long-term latent shocks are much more severe than those in the early stages of innovation, in other words, collapses after long-term booms are worse than short-term ones (Dell' Ariccia et al,2012). As confidence in innovation grows, once a shock occurs, the average payment failure rate rises, and the cross-sector differences in the payment failure rate rise first and fall later. (A social system asymmetrical with agent information)There is also moral hazard. Because of laziness, lack of incentives or pessimistic expectations upon innovation results, inefficient agent entry will low down the investment in the field of innovation.

As the conclusion of Ana M. Fernandes, Caroline Paunov (2015), organizational institution innovation, just as product innovation, is confronting the risk of insufficient management ability of innovators.

To sum up, no matter product innovation or institution innovation, there are two kinds of innovation risks, including system internal risk and system external risk. Internal risks cover moral hazard and capability risk, capability risk involves resource ability risk and management ability risk. The external risk includes the game risk from opponents and the natural risk, the game risk from opponents refers to the attack and destruction from competitors, the natural risk denotes risks from the world endogenous change by non-human factors or inherent uncertainty, including periodic psychological fluctuations in a social system. Whether the innovation risk exists or not, the size of the risk is relative to the capacity of a social system.

Different social systems have different attitudes towards risks. Mountaineering enthusiasts from all over the world are often killed around Mount Everest. In 2016, Chinese sailor Guo Chuan disappeared in the Pacific Ocean. In the 1990s, Beijingers staged their bitter experience in New York City of U.S. The Republic of China story "*Shanghai Beach*", Xu Wenqiang landed in Shanghai. All of them were risk lovers, knowing that the environmental risk is huge, they still aggressively got involved. Some risk management gets out of control, which would be attributed to the ignorance of the social system. Chinese Zhou Youwang of Western Zhou Dynasty (795-771 BC), to please his pet concubine Baosi, teased dukes by the beacon fire, resulting in the extinction of his country.

2.2 Risk Control for innovation

How to manage the risk of innovation? Li Xiaofeng (2005) sorted the risk into five levels: low risk, lower risk, general risk, higher risk, high risk. He proposed the establishment of a pre-warning management system to control future risks. The function of risk pre-warning management system includes: (1) risk monitoring and forecasting, (2) risk detection and diagnosis, (3) selection of risk prevention measures.

Li Xiaofeng's risk management methods are consistent with management forecast thoughts. To personal system or organizational system, Li Xiaofeng's management methods are applicable. In the future, innovative risk management will be incorporated into the forecasting management of social system. Risk management and forecasting management will become the routine management work of social system. Besides the management control theory embodies the feedforward-control thought of forecast management, the control on real circumstance in operation process is more important. Especially in an environment of high uncertainty, the feedforward-control system could only be a kind of reference, and the real circumstance mentality, skills of a social system often play a decisive role. 'Knowledge comes from practice", "practice creates real knowledge", the enhancing of risk prevention ability comes from practice and study in common days.

When the social system thinks the risk of innovation controllable, then the cost and benefit of innovation will be assessed.

3. INNOVATION COSTS AND REVENUES

Although innovation costs could be controlled, innovation activities are not likely to occur when innovation costs exceed the capacity of the social system.

3.1 Three Dimensions to Analyze Innovation Costs and Revenues

Li Xin, Wen Guijiang (2014) made a representative conclusion, they categorized the cost bearer of technology innovation life cycle into three kinds: enterprise costs, consumer costs and environmental costs. These three costs are collected according to the five stages of technological innovation life cycle, e.g, the cost of decision making, the cost of research and development, the cost of manufacturing, the cost of commercialization for results, the cost of maintenance. They think, The higher in upstream stage of an industry chain, the greater the impact from technology innovation cost upon the cost of the whole innovation process. The innovation cost should not only be counted as a whole, but also be independently counted for each stage.

The conclusion of Raluca Bunduchi, Alison U. Smart (2010) is not only suitable for the cost of technological innovation, but also suitable for the research upon institutional innovation costs of

organizations. They sorted the cost of inter-organizational process innovation into six aspects: the exploring cost at the stage of generating innovation, the cost of starting up, the transformation cost at the stage of accepting innovation, the cost of capital (uncertainty of input costs), the cost at the stage of implementing innovation, the cost of relationship (cost related to lack of trust).

Meng Hao, Wang Lijie (2003) specially researched the learning cost and the risk cost. Their viewpoints, the cost structure of enterprise innovation integration can be sorted into six kinds: (1) introduction costs, (2) communication costs, (3) learning costs, (4) friction costs, (5) bottleneck costs, (6) risk costs. Their sights are universal to technological innovation, institutional innovation.

Without an expectation for revenue growth or utility, usually, innovation will not occur. A growth in income or utility is the ultimate goal of social system innovation. A mature social system not only estimates the innovation cost, but also predict the benefits of innovative projects. A common practice in theoretical world, link costs with benefits when researching.

Yuan Dejun's (2001) theory of financial innovation costs has great referential significance for the research upon technological innovation costs as well as institutional innovation costs. He summarized the cost of financial innovation with three formulas, internal costs of financial innovation = design costs + start-up costs + marketing costs + adjustment costs, external costs of financial innovation = friction costs + supervision costs, the total costs of financial innovation = the internal cost of financial innovation + the external cost of financial innovation. The benefits of financial innovation include, (1) direct income, (2) indirect income; there are three main factors affecting the financial innovation income: (1) the conformity degree between the innovative design program and the market demand, (2) the monopoly degree of the innovation subject upon the innovation measures, (3) the frugal degree of innovation costs. From the actual experience, Yuan Dejun's direct income, indirect income concepts of innovation have a general sense.

Qi Xin, Zhang Jiandong (2008) sorted the cost and revenue of enterprise innovation into three situations: independent innovation, imitating innovation and cooperative innovation, which has universal guiding significance to the innovation of social system. Their opinion, the benefit of independent innovation includes monopoly advantage, industry standard income, and the independent innovation cost includes the continuous input and organization cost to maintain the market advantage. The revenues of imitating innovation mainly include capital saving, time saving and the avoiding of independent innovation costs. The cost of imitating innovation mainly covers the cost of technology introduction, the learning cost. The risk of imitating innovation mainly involves the high difficulty technology link hard to digest, the leading enterprise with too

fast speed updating technology. The imitation innovation also has the opportunity cost. The cooperative innovation benefit mainly includes the tangible income, such as funds, equipments. Its intangible income mainly includes patent, the knowledge generated by innovation. The cost of cooperative innovation mainly includes the cost of partner search, the input cost of materials, funds, equipments and personnel of cooperative project, and the coordination cost of cooperative enterprises.

In summary, from the research above, we can see that innovation cost-revenue analysis has many dimensions (Table 1), the first dimension is from the time process of innovation (Raluca Bunduchi, Alison U. Smart2010, Li Xin, Wen Guijiang 2014, Meng Hao, Wang Lijie2003), the research on innovation costs along with the innovation process would be comparatively explicit, (1) the cost before the innovation process, involving the cost of investigation, the cost of evaluation, (2) the cost during the innovation process, including all kinds of resource input, (3) the cost of maintenance after innovation, (4) the cost of transformation for innovation achievements. Any innovation will more or less include the cost of learning, friction with the environment, risk control. The second dimension is from the perspective of innovation space. Yuan Dejun (2001) sorted innovation costs into internal costs, external costs, sorted innovation income into direct income and indirect income. External costs will include the cost of friction with environment and the cost of risk. The third dimension is based on the original degree of innovation. Qi Xin, Zhang Jiandong (2008) researched the cost and revenue of innovation from the angle of independent innovation, cooperative innovation and imitation innovation. In practice, the cost-revenue analysis of innovation can be carried out from these three angles at the same time, so as to draw a more systematic conclusion.

Table 1: The matrix to evaluate an innovation

	Time dimension			Space dimension		Original dimension			Economics period dimension	
	Before innovation	During innovation	After innovation	System internal	System external	Independent innovation	Cooperative innovation	imitating innovation	Short term	Long term
risks										
costs										
revenue										

3.2 Soft Innovation——Cost-Revenue of Government Institutional Innovation

From 2013 to 2017, the State Council issued nearly 60 policies and regulations concerning mass

entrepreneurship and mass innovation, involving the "*Implementation Opinions from General Office of State Council, to Build the Model Base for Mass Entrepreneurship & Mass Innovation* " (May 2016), the "*Guiding Opinions from State Council, on Speeding up the Construction of Support Platform for Mass Entrepreneurship & Mass Innovation*" (September 2015), and "*Opinions from General Office of State Council, on Strengthening the Main Position of Technological Innovation Enterprises and Promoting Innovation Ability of Enterprises in an All-round way*" (February 2013). Chinese Ministry of Education has also issued a number of policies to encourage innovation as well as entrepreneurship education. Including the "*Opinions of the Ministry of Education on Vigorously Promoting Innovation and Entrepreneurship Education in Colleges and Universities*" (May 2010), "*Basic Requirements upon Entrepreneurship Education in Ordinary Undergraduate Campus (Trial)*" (August 2012), and "*Notice from General Office of the Ministry of Education, Report the Implementation Measures for the Reform Program of Deepening Innovative Entrepreneurship Education*" (September 2015). The Ministry of Education also established the Research Center for innovative Entrepreneurship Education in 2016. Related local policies have also been issued in succesion, Anhui Provincial Government Office in 2015 pushed forward "*Implementation Opinions from Anhui Provincial Government, on Deepening Reform for Innovation and Entrepreneurship Education*". By 2016, the social mental consensus for mass entrepreneurship & mass innovation in the China, dedicated to the great rejuvenation of the whole country, has been formed as a whole. Most colleges and universities in the eastern region have explored a suitable path for mass entrepreneurship and innovation education, A transformation development platform for mass entrepreneurship and innovation education established. Taking Bengbu University as an instance, it has participated in the Alliance of Applied Undergraduate Universities in Anhui Province, constructed a trans-provincial alliance for Bengbu University, Changshu Institute of Technology, and Guizhou Institute of Technology. It has established an exchange education relationship with Hankisan University in Korea as well as Troy University in U.S, and has also established friendly relations with universities in Britain, Germany and other countries. So far, Bengbu University has established university-government cooperation, university-enterprise cooperation (such as entrepreneur teaching on campus, cooperation with Fengyuan Group), university-university cooperation, internship and employment training base, mass entrepreneurship and innovation faculty training, teaching and curriculum reform, the classroom extending to the enterprise and the society, the reform of the evaluation mechanism for pupils, the reform for teaching, the evaluation mechanism of teachers, the reform of scientific research and innovation culture, a transformation platform for the reform of university management culture and the reform of university management system. As a whole, Bengbu University stepped into the reform forefront of the same type colleges and universities throughout the country. The transformation and development platform of innovative entrepreneurship education in Bengbu University can also

be evaluated with Table.1 (Table.2). Of course, Chinese universities have the government at their back, to mass entrepreneurship and innovation education transformation and development, the overall risk is very small, the difference would be costs and time efficiency. From the perspective of economics period, the potential of long-term benefit from innovation & entrepreneurship education is inestimable, universities are the center of social civilization, and they have strong positive spillover effect to society.

Table 2: The matrix to evaluate the transformation for a double innovation development of Bengbu University

	Time dimension			Space dimension		Original dimension			Economics period dimension	
	Before innovation	During innovation	After innovation	System internal	System external	Independent innovation	Cooperative innovation	imitating innovation	Short term	Long term
risks costs revenue										

Fan Dengyi (2007) researched the cost-revenue of government information institution innovation, which is helpful to the research of current Chinese policy on mass entrepreneurship and innovation. The possible costs of government information disclosure are: (1) hard costs, such as costs of investigation and research, and the purchase of software as well as hardware, software exploring costs, maintenance and management costs, (2) institution design costs, (3) risk costs. Possible benefits, (1) government revenues, (2) social revenues, (3) enterprise revenues.

Fan Dengyi's research (2007) also unveiled that it is relatively difficult to research the cost-revenue of government institution innovation by the angle of accounting cost. Generally, it should be researched from the angle of social cost in the sociological sense. In other word, besides the accounting cost-revenue in economic sense, the cost-revenue of institution innovation should also cover short-term, long-term social costs, even social fluctuation and so on.

4. SYSTEMATICALLY UNDERGO EVALUATION ON PERSONAL ENTREPRENEURSHIP AND INNOVATION

For individual management and development, costs and risks usually affect a person's decision on the innovation entrepreneurship. Based on the above research, the cost-revenue of individual innovation and entrepreneurship can also be sorted into two categories: the first is measurable

short-term direct cost, revenue, the other is non-quantifiable long-term indirect cost, revenue (Table 1). For example, to cultivate a human resource of a four-year undergraduate, (1) the short-term direct cost of four years = four years tuition + four years living expenses, travel expenses + four years expected income of working if without college career. The expected income without college career is a relative loss, or opportunity cost, not actual accounting cost. (2) The immeasurable long term indirect cost = the risk of capital occupation of low income families + the risk of human resource training failure. Low-income families invest a lot of money on college pupil's study and living expenses, which results in a shortage of funds. Once the family has a negative random event demanding large sum money, the family economic crisis might occur. The risk of human resource training failure exists objectively, such as the pupil could not graduate on time, fail to obtain academic certificate, or even unexpected accident, disability, death in campus or other small probability events. (3) The measurable short-term direct income of four years = the overall improvement for the family human resource structure. (4) The unmeasurable long-term income = the enhancing for corresponding undergraduate's social survival capacity + the improvement for the family's social reputation+ the enhancement for family's comprehensive competitive capacity + the growth of the family's spiritual wealth + the expected future growth of the family's material wealth + the future expectation upon an increase for the family's happiness. If investigated from the whole society, the bring-up of a college pupil will also generate cost spillover effect as well as benefit spillover effect. The cost spillover effect is reflected in the country's annual investment in each university pupil, which is transformed into the invisible income of the family. The benefit spillover effect is embodied at the cultivation of college student's mental attribute and knowledge quality, which can benefit the social groups around him (Table 3).

Table 3: The matrix to evaluate the innovation of an education for creating a college pupil

	Time dimension			Space dimension		Original dimension			Economics period dimension	
	Before innovation	During innovation	After innovation	System internal	System external	Independent innovation	Cooperative innovation	imitating innovation	Short term	Long term
risks										
costs										
revenue										

5. SUMMARY

There are various kinds of innovation and entrepreneurship, so it is not easy to give a general formula evaluating risk, cost and income. However, the research above is beneficial, (1) to

further personal，family or organization rationality on innovation, with awareness for risk, cost, revenue, no blindly innovation, no blindly input, so as not to be trapped by innovation, this kind of awareness is precious to high-risk projects, high-risk social environment, low knowledge individual systems as well as families; (2) for technological innovation, such as personal invention, major economic investment, the cost-revenue can be researched according to the process of innovation (Xie Kefan, Li Xiaoqun 1996, Raluca Bunduchi, Alison U. Smart 2010, Li Xin, Wen Guijiang 2014); (3) there is a difference in innovation degree, e.g. the difference among independent innovation, imitation innovation, cooperative innovation (Qi Xin, Zhang Jiandong, 2008), (4) to research the cost of innovation more comprehensively, we can also observe it from a spatial perspective (Yuan Dejun 2001), researching the internal as well as external costs of innovation, (5) any innovation will involves, to various degree, the cost of learning, the cost of friction with environment, the cost of risk control, (6) the research upon the cost-revenue of soft innovation, such as thoughts innovation, management innovation and institution innovation, is a more complex issue, which should be sorted into measurable short-term direct cost-revenue and immeasurable long-term indirect cost-revenue according to the specific situation, such as many social science research projects, human resources investment, personal and family management system reform, a plan for job seeking beyond conventional residential place, major tourism plans, etc., (7) general innovation projects, whether institutional innovation or technological innovation, will cause a spillover effect of the cost-revenue to the society.

It should be noted that the innovation evaluation matrix in Table 1 can provide a more detailed items combined with specific item, for example, evaluate university by teaching department, assess major innovation projects of organization or individual by accounting subject.

Innovation management can not run beyond management principles, emancipating the mind is the key to innovate, which embodies the important principle of management——human heart principle. The evaluation of innovation, ultimately, is the evaluation on the ability of a particular social system compared to the change in its living environment: an eternal topic of management and management theories.

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Author's Information

Guicheng LUO

(1970-), male, a teacher of Bengbu University, Anhui, China, with a master degree of management, senior lecturer, spending most of his time on personal management, evolution of social system, politics, Xi Jinping Thoughts, political economics, religion etc．

Jie Wu

(1972-), male, a professor on food chemistry, an experts with many patents approved by Chinese Gov.