Establishment of Elastic Model for Interrupt and Recovery of Commercial Bank IT System

Jing Chen
South China University of Technology
Guangzhou, 510000, China
cjcj@ibhsedu.com

ABSTRACT: *Financial industry is the core of the normal operation of national economy. As the main force of financial industry, commercial banks shoulders main economic responsibility, whose safety directly influences economic operation of the whole country. The rapid development of IT provides a powerful tool for improving efficiency of commercial bank. Integration of IT and commercial banks brings a new chance and improves the efficiency and accuracy of business processing. But commercial banks also need to face the threaten and challenge brought by IT. Thus it is urgent to effectively manage IT system of business bank. Theory of elasticity originated from 1970s. As time goes by, theory of elasticity has been widely applied in various fields such as supply chain management, ecological system, etc. Based on theory of elasticity, this study researched interrupt and restoration management for IT system of business bank, in order to provide more scientific management method and reduce the damage brought by IT system interruption.*

Keywords: Theory of Elasticity, IT System of Commercial Bank, Interruption Risk, System Restoration

Received: 30 August 2016, Revised 3 October 2016, Accepted 9 October 2016

1. Introduction

With the development of IT, operation of the whole society combines closer with IT. As the important constituent part of world economic core, commercial banks make full of the huge advantage brought by informatization in the rapidly informationalized society; however, the risks also come.

Wang Yun pointed out that, risk identification based on the risk assessment of project needed to identify various exposed and potential risks; practically, risk assessment is an imagination and guess of the possible risk event; risks could be generally divided into three kinds: environmental risk, technical risk and business risk in the perspective of the source of risk of IT system of banks [1]. Liu Qiulian put forward that, risk management of information system in commercial bank in China has the following countermeasures: (1) improvement and control of software implementation; (2) establishment of strategy of data backup, disaster backup and disaster recovery; (3) establishment of IT continuity plan and business continuity plan; (4) establishment of auditing system of information system [2]. Liu Fei mentioned in her study that, the importance and necessity of IT risk management for banks could not be ignored due to the abruptness and wide influence of IT risk and its great influence on banks; IT risk always existed with the operation of banks and could not be solved immediately, thus certain mechanism needs to be established in order to monitoring the possibility of IT risk occurrence. Based on that, she proposed to monitor IT risk management of banks in the microscopic perspective, form risk awareness in the whole organization, continue to monitor in the process, thus to lower IT risk to the acceptable level [3]. Li Yonghong et al. analyzed the response behavior of elastic system of supply chain under the condition of risk loading and unloading and the breakdown of elastic system of supply chain, which provides a referable theoretical method for the shape of elasticity of supply chain system and enhancement of the risk defense ability[4].

Based on elastic theory, this study made an detailed analysis on the connotation of elasticity of IT system of commercial bank and proposed relative management method for improving elasticity of IT system of commercial banks. This study has important theoretical significance and application value.

2. Elastic Theory

The concept of elasticity originating from material science refers to the ability of material restoring to the initial shape after affected by external force. Many scholars have given definition about elasticity [5]. Bruneau et al. thought that, elasticity is an ability of a system, i.e., an ability of impact reduction and an ability that absorb impact and restore to an acceptable level [6].

Supply chain, a complex network organization, faces various categories and a large amount of risks. Meanwhile, elasticity is widely describes as reaction capacity of an organization to impact and recovery capacity in current commercial environment. Therefore, elasticity becomes important in risk management of supply chain. Robustness is an important factor in elasticity of supply chain [8]. It can be understood as the vigorousness of system and refers to system maintaining some properties under certain parameter perturbation. It is the key of survival when the system is abnormal and dangerous. Preventing the risk of supply chain should first strengthen the robustness of supply chain, to prevent it from the influence of risk event. Purpose of robustness is to establish and maintain a supply chain integrating robustness and elasticity because robustness supply chain is without adaptive capacity and meanwhile modern supply chain is easy to be influenced by risk event. Therefore, a reliable processing mode is to balance robustness and elasticity. On the one hand, we should prevent supply chain from influence of risk time or make the loss under risk event least; on the other hand, supply chain can restore to normal or ideal state in the rapidest way after affected by risk.

3. Elasticity Model For Restoration of Commercial Bank System Based on Elasticity Theory

This study analyzed and discussed the elasticity of IT system using the concept of elastic triangle and established elasticity model.

As to the interruption of IT system of commercial banks, first give assumption and some necessary explanation of symbol.

(1) Performance of IT system of commercial banks is recorded as Q (t), $0 \le Q(t) \le 1$, performance of system under normal state Q(t)=1, but if IT system is completely paralyzed under the impact of extreme events, then system performance Q(t)=0;

(2) Suppose the impact strength of the event that interrupt system is I.

(3) Suppose the reaction time of decision maker is 0, i.e., the time from interruption of IT system of commercial banks to bank manager finding the interruption and taking action is 0;

(4) Suppose the IT system of commercial bank interrupts after impacted at t_0, then the bank takes action to recover the system and the system recovers to an acceptable level or normal state after recovery time of T;

(5) Suppose the recovery time of system interruption has a upper limit T*. If the actual recovery time of system exceeds this upper limit, i.e., then the elasticity of the system is 0.

(6) Suppose at t0 (the time point that interruption occurs), immediate loss of interruption to the performance of IT system is L, and the range of L satisfies: $0 \le L \le 1$;

(7) Suppose the maintenance cost on system at the early is q1 and the repair cost after the interruption occurs as q2.

In order to more clearly express the assumptions above, here the interruption problem is expressed by elastic triangular figure, as shown in figure 1.

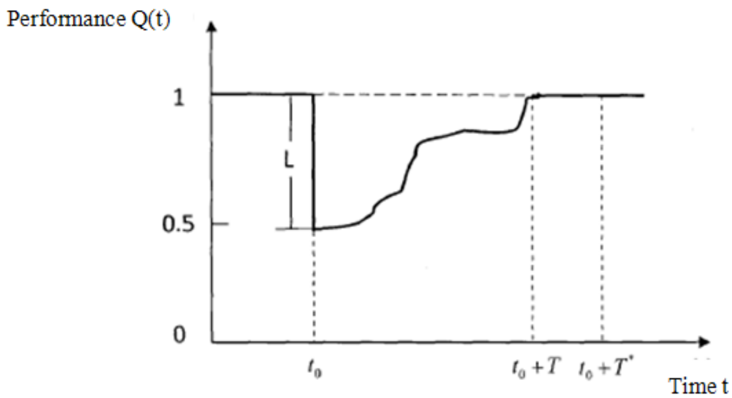

Figure 1. Elastic model for terminal recovery when IT system of commercial banks interrupts

Based on the previous assumptions, loss of interruption to banks is expressed as:

$$S = \int_{t_0}^{t_0+T^*} (1-Q(t))\, dt = \int_{t_0}^{t_0+T} (1-Q(t))\, dt = T - \int_{t_0}^{t_0+T} Q(t)dt \tag{1}$$

From the above formula, it can be known that, the scope of damage to system S: $0 \le S \le T \le T^*$. Thus the elasticity of recovery of IT system terminal can be expressed. It is expressed by the percentage of loss, as shown in the following:

$$R = \frac{\int_{t_0}^{t_0+T^*} Q(t)\, dt}{\int_{t_0}^{t_0+T^*} 1dt} = \frac{\int_{t_0}^{t_0+T^*} 1dt - S}{\int_{t_0}^{t_0+T^*} 1dt} = \frac{T^* - S}{T^*} = 1 - \frac{S}{T^*} \tag{2}$$

The small the loss S is, the bigger the elasticity of system is. It can be known from formula (2). The scope of R is [0,1]. When S=0, then R=1.

Robustness of the system is related to the maintenance cost in early stage q1 and impact strengthen of extreme event I, therefore

$$L = L(q_1, I) \tag{3}$$

In addition, the higher the cost in early stage is, the smaller the loss L is, and the larger the impact strength is, the larger the loss L is.

According to the trend of curve Q (t) in figure 4, the expression of system performance can be expressed in the form of piecewise function:

$$Q(t) = \left\{ \begin{array}{c} 1, \ t \langle t_0 \\ 1-L, \ t = t_0 \\ g(t), \ t_0 \langle t \le t_0 + T \\ 1, \ t \rangle t_0 + T \end{array} \right\}, \tag{4}$$

That formula expresses that, before impact and after impact, i.e., when t<t0 and t >t0+T, performance function of system Q (t) =1; at the moment of impact, the performance function of system immediately reduces to Q (t) =1-L; in recovery stage, performance function of system is Q (t) =g (t). Thus recovery velocity of system is:

$$V(t) = \frac{dQ(t)}{dt} = \frac{dg(t)}{dt}, \; t_0 < t \leq t_0 + T \tag{5}$$

This is because the recovery velocity of system is not only related to the cost input q2 after interruption, but also related to the input in early stage q1. Recovery velocity is expressed as:

$$V(t) = (\alpha_1 q_1 + \alpha_2)\, q_2 \tag{6}$$

Where α1 and α2 are multiplier. Thus

$$\frac{dg(t)}{dt} = (\alpha_1 q_1 + \alpha_2)\, q_2 \tag{7}$$

We get:

$$g(t) = \int (\alpha_1 q_1 + \alpha_2)\, q_2\, dt = (\alpha_1 q_1 + \alpha_2)\, q_2\, t + C \tag{8}$$

In addition, because g(t0)=1-L, thus

$$(\alpha_1 q_1 + \alpha_2)\, q_2\, t_0 + = 1 - L \tag{9}$$

We get:

$$C = 1 - L - (\alpha_1 q_1 + \alpha_2)\, q_2\, t_0 \tag{10}$$

Therefore, we get the function expression of g(t):

$$g(t) = (\alpha_1 q_1 + \alpha_2)\, q_2 (t - t_0) + 1 - L \tag{11}$$

It is linear function. Thus the expression of system performance Q(t) is:

$$Q(t) = \left\{ \begin{array}{c} 1, \; t \leq t_0 \\ 1 - L, \; t = t_0 \\ (\alpha_1 q_1 + \alpha_2)\, q_2 (t - t_0) + 1 - L, \; t_0 < t \leq t_0 + T \\ 1, \; t \leq t_0 + T \end{array} \right\} \tag{12}$$

Moreover, as Q (t0+T)=1, recovery time of system T can be figured out:

$$Q(t_0 + T) = (\alpha_1 q_1 + \alpha_2)\, q_2 (t_0 + T - t_0) + 1 - L = 1 \tag{13}$$

We get

$$T = \frac{L}{(\alpha_1 q_1 + \alpha_2)\, q_2} \tag{14}$$

In order to better express the performance of the system in figure, the sketch map for the elasticity of system performance can be revised into the following figure based on the expression of system performance Q(t).

Thus the loss of system is:

$$S = T - \int_{t_0}^{t_0} Q(t)\, dt = LT / 2 \tag{15}$$

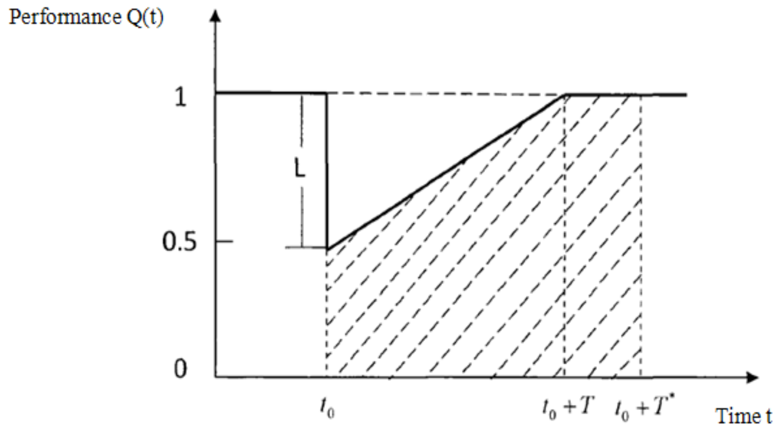

Figure 2. Elasticity model for recovery of interruption

Then the elasticity of system is got:

$$R = 1 - \frac{S}{T^*} = 1 - \frac{LT}{2T^*} \tag{16}$$

Where $L = L（q_1, I）$, $T = \frac{L}{（\alpha_1 q_1 + \alpha_2）q_2}$.

As $L \leq 1,\ \ T \leq T*$, we get:

$$R = 1 - \frac{LT}{2T^*} \geq 1 - \frac{T^*}{2T^*} = 0.5 \tag{17}$$

If and only if L=1 and T=T* , the equality of formula (3-17) holds; moreover, as $R = 1 - \frac{LT}{2T^*} \leq 1$, and when L=0 and T=0, R=1, thus the scope of R is [0.5,1].

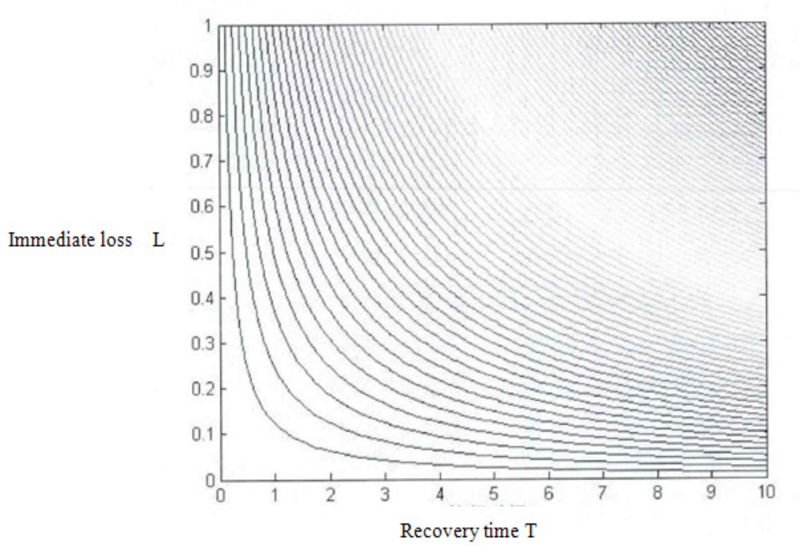

Figure 3. Elasticity curve

Because the change of q1 and q2 only directly influences the immediate loss L and recovery time T, thus we can make R=R (L, T). R=R (L, T) is used to analyze the relationship of system elasticity R, immediate loss L and recovery time T. It is known from formula (2-16) that, the value of R is determined by L and T. Generally, different combination of L-T determines different R, but different combination of L-T determines the same R also exists. For instance, $R\ (\frac{1}{2}L_0,\ T_0) = R\ (L_0, \frac{1}{2}T_0) = 1 - \frac{L_0 T_0}{4T^*}$. To clearly express the relationship between R and L-T, here it is expressed in figure, as shown in figure 3. In figure 3, value of elasticity obtained from all combination of L-T on every curve is equal, which is called contour line. The curve that is the closest to the left bottom expresses the largest elasticity; and the curve that is the closest to the right top expresses the smallest elasticity. With the figure, different combination of L-T can be easily distinguished and compared.

3. Analysis And Simulation of Example

Assume that there are five commercial banks A-E suffering from interruption event with different damage strength at different time point, and the decrease of system performance and recovery time of these five banks are both different, as shown in table 1.

Commercial bank	Time point of damage	Strength of interruption event	Interruption event	Impacted performance	Recovery time
A	t1	I	1	0.6	1.5
B	t2	2I	2	0.3	4
C	t3	1.5I	3	0.4	5
D	t4	0.5I	4	0.8	1
E	t5	I	5	0.5	3

Table 1. Description of value

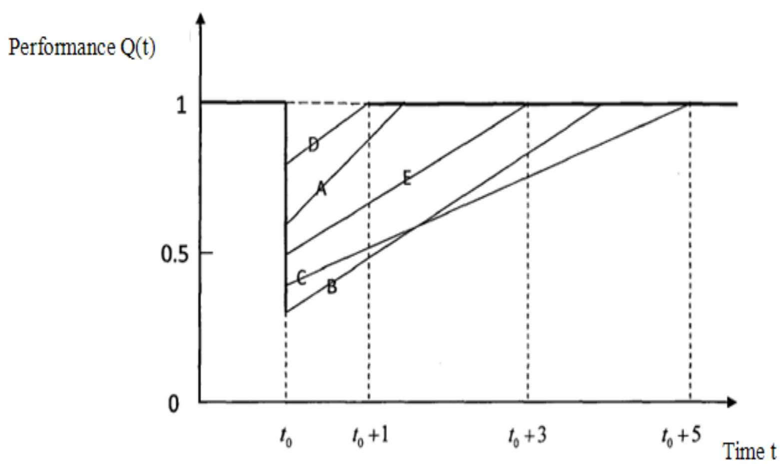

Figure 4. Curve of system performance in five interruption situations

Performance curve is drawn for comparison of the five banks, as shown in figure 4. Based on the analysis on the figure, it is found that, the recovery time needed by bank B is shorter than bank C. It is not conflict with the reality. The robustness of system directly influences the performance after interruption occurs, and the former one is in direct proportion to the latter. When the system is interrupted, higher cost in emergency rescue will result in shorter recovery time. Generally, the recovery time of terminal of the system will not exceed 10 hours. If the recovery time exceeds 10 hours, then the bank will suffer from invocatable loss and even close down. Thus T* is supposed to be 10. According to figure 4 and the theoretical consensus above, elasticity value of five systems can be figured out. Table 2 lists terminal immediate loss L, recovery time T and system elasticity R under five situations.

Situation	Interruption immediate loss value L	Recovery time T	System elasticity R
A	0.4	1.5	0.97
B	0.7	4	0.86
C	0.6	5	0.85
D	0.2	1	0.99
E	0.5	3	0.925

Table 2. Elasticity value of interruption event

Next, elasticity of these systems is marked in the same elasticity elastic equation figure, to make them clearer. From figure 5, we can directly see the relationship between points, elasticity value: RD>RA>RE>RB>RC, interruption immediate loss: LB>LC>LE>LA>LD, recovery time: TD>TA>TE>TB>TC. We can find that, elasticity value of system depends on system immediate loss L and recovery time T. If immediate loss L is small and recovery time T is short, then the elasticity of system is large.

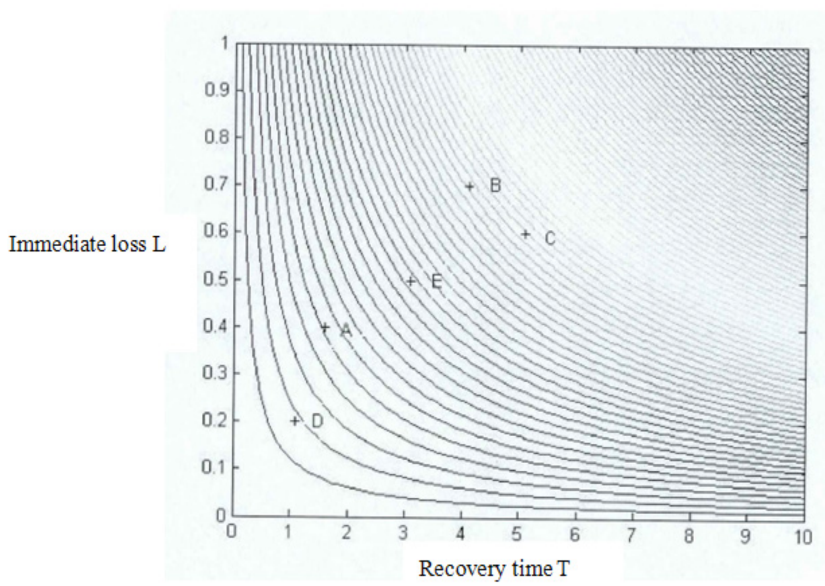

Figure 5. Elasticity of system under different interruption events

When IT system of commercial bank interrupts, elasticity of the system should be improved to lower the loss. To improve the elasticity of the system, we should increase the robustness of the system, i.e., decrease L, and improve the recovery time of interruption, i.e., shorten recovery time T. The following are suggestions for increasing robustness of the system: (1) more importance should be attached to the establishment of information technology of financing institutions, and information technology department and application development department should be improved; (2) more investment should be put into the establishment and maintenance of system, to make the system have low risk; (3) independent research and development ability should be improved especially, and the reliability risk of the system should be decreased. To improve the recovery speed of system terminal, we should: (1) strengthen the force on the establishment of standby system and establish redundant system architecture of availability; (2) emphatically establish database disaster recovery system and reduce data loss; (3) carry out emergency exercise in different business system.

4. Conclusion

This study first analyzed the characteristics of the risks faced by the IT system of commercial banks, then established elasticity model of IT system of commercial bank based on elasticity theory, and analyzed the elastic ability presented by the IT system of commercial banks under unexpected risk by quantitative method. Moreover, this study made numerical simulation on the model established and drew a conclusion that, the elasticity of the system is correlated with the robustness and recovery speed of the system, and gave some detailed suggestions for the management work of IT system interruption of commercial bank. Based on the analysis of numerical simulation results, it is known that, the data and conclusion obtained using the elasticity management model established and the elasticity measure method proposed basically conformed to the practical situation. It proves the reasonability of elasticity model for interruption and recovery of IT system of commercial bank based on elastic theory, and this study provides certain reference value for the management of interruption and recovery of IT system of commercial banks in reality.

References

[1] Wang Yun. Risk and Effective Management in IT System Project in Bank . J. Project Management Technology, (s1):54-57 .2008,

[2] Liu Qiulian. Risk Management and Strategy of Information System in Commercial Bank. J. Value Engineering, 30(3):166-167. 2011,

[3] Liu Fei. Discussion of IT Risk Management Strategy of Bank Based on IT Government. J. Modern Business Trade Industry, 26(11):123-124. 2014,

[4] Li Yonghong, Zhao Lindu. Analyzing Supply Chain Risk Response Based on Resilience Model. J. Journal of Systems & Management, 19(5):563-570. 2010,

[5] Zhu Xinqiu, Chen Guoping. Review of Research on Resilience Supply Chain. China Business and Market, 25(3):43-47.2011,

[6] Bruneau M, Chang S E, Eguchi R T, et al. A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. J. Earthquake spectra, 19(4):733-752. 2003.

[7] Ye Di. Supply Chain Network in the Perspective of Complex Network. J. Modern Management Science, (8):111-113. 2011,

[8] Li Bin, Ji Jianhua, Li Guowei. Study on Supply Chain Robustness Index Mode Considering Profits and Risks. J. Journal of Shanghai Jiaotong University, 47(3):484-489 .2013.