

## Coupling Mechanism between Financial Innovation Process and Financial Innovation Environment

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**Abstract:** The financial innovation and its environment are both complicated nonlinear systems. Classic research methods are difficult to give financial innovation a reasonable elaboration on the question about the self-adaptive feature and the relationship with environment, so coupling mechanism will provide a new direction. This paper introduces the principle of coupling situation model and this model is used to study the method of interactive coupling mechanism. According to this method, authors analyze the development trend of interactive coupling between financial innovation and innovation environment and their state pattern rules. At last its trend path and development mode has been analyzed.

**Keywords:** Financial innovation process, innovation environment, coupling mechanism

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### I. INTRODUCTION

Making a general observation of economy developing history, we can find that financial innovation appears on a certain stage of development of economy, and evolves in the process of development of economy. The evolution trend of financial innovation is as follows: under the underdeveloped economic background, the financial innovation is simple, while under the developed economic background, the financial innovation is complicated. That is to say, financial innovation evolves with the change of economic environment. The analysis of financial innovation in the new classical economic is usually under the framework of static equilibrium and focused on the motivation and effect of the innovation. But, the traditional method cannot give a reasonable elaboration on the question about the self-adaptive feature and relationship with environment. Also, it cannot help with the effective explanation on the internal mechanism of financial innovation and the interaction between the behavioral agent and environments. The traditional analysis cannot guide the practice of financial innovation. Therefore, we must take it as a complex large system from the perspective of systematic and evolutionary.

### II. THEORETICAL ANALYSIS ON THE RELATIONSHIP BETWEEN TWO SUBSYSTEMS

There is the coupling relationship between financial innovation process system and environment system, which is embodied by the complex interactive stress and constraint mechanism between them. The intensified efforts on development of financial

innovation will form a stress effect on innovation environment. For instance, financial institutions will keep producing new products and services, which makes financial disintermediation becomes more and more severe, to benefit from the loopholes of regulations and laws so that the problems of the macroeconomic regulation and control policy failure are appeared. In this circumstance, subject bodies in the environment will take measures to respond these problems caused by innovation. This action will improve the environment situation. In addition, the change of external innovation environment also bring motivation to the patterns shifting of financial innovation, which is embodied in that the innovation process should meet the new regulations and laws, and cater to the new market demands, such as the development of Internet technology and etc.

Coupling situation refers to the objective characterization of interactive stress and interdependence relationship among systems or system elements. From the perspective of synergetics, we can see what determines which kind of order and structure system will trend to in a critical region is the coupling effect and coupling degree. That is to say, the coupling degree determines the trend of the system from disorder to order. Therefore, coupling situation characterized, in a certain extent, the system's the trend of high-level and the sustainable development. Through the evaluation and analysis of the coupling situation it cannot only focus on system's coupling degree, but also make objective analysis and judgment to influence of the sustainable and coordinated development of the system.

### III. THE CALCULATING MODEL OF THE COUPLING DEGREE

Under the premise of understanding the interactive coupling relationship between financial innovation process and financial innovation environment, interactive coupling system dynamic equilibrium model has been established through the idea of system evolution in the general system theory to analyze the status of the whole system consisting of financial innovation process and financial innovation environment.

The two subsystems are both nonlinear systems whose evolution equations are as following:

$$dx(t)/dt = f(x_1, x_2, \dots, x_n), i = 1, 2, \dots, n \quad (1)$$

$(x_1, x_2, \dots, x_n)$  is the nonlinear function of  $x_i$ .  $f(x_1, x_2, \dots, x_n)$  is expanded at  $x = 0$  based on the Taylor series.

$$f(x_1, x_2, \dots, x_n) = f(0) + a_1x_1 + a_2x_2 + \dots + a_nx_n + \theta(x_1, x_2, \dots, x_n) \quad (2)$$

Denote:  $f(0) = 0$  is obtained based on the Taylor series;  $a_i$  is the partial derivative values of  $f(x_1, x_2, \dots, x_n)$  whose partial derivative with respect to  $x_i$  at  $x = 0$ ;  $\theta(x_1, x_2, \dots, x_n)$  is equal to or more than a quadratic analytical function.

According to *Lyapunov Theorem of First Approximation*,  $\theta(x_1, x_2, \dots, x_n)$  in function (2) is omitted to ensure the stability of system. The function (3) which is the approximate linear system is obtained to discuss the character of function (1).

$$dx(t)/dt = \sum_{i=1}^n a_i x_i, i = 1, 2, \dots, n \quad (3)$$

The general functions of the system of financial innovation process and financial innovation environment are established according to above method.

$$f(P) = \sum_{i=1}^n a_i x_i, i = 1, 2, \dots, n \quad (4)$$

$$f(E) = \sum_{i=1}^n b_i y_i, i = 1, 2, \dots, n \quad (5)$$

Denoted:  $x_i, y_i$  are the index of financial innovation process system and financial innovation environment system respectively;  $a_i, b_i$  are the weights of each index.

There are only two elements of  $f(P)$  and  $f(E)$  in the whole system. According to the *Bertalanffy Theorem of General System*,  $f(P)$  and  $f(E)$  are the main parts of the whole system, so the form of the system evolving function is:

$$\begin{cases} A = df(P)/dt = \alpha_1 f(P) + \alpha_2 f(E) \\ B = df(E)/dt = \beta_1 f(P) + \beta_2 f(E) \end{cases} \quad (6)$$

The evolutions of financial innovation process system and financial innovation environment system under the affection of themselves and external environment are denoted respectively by  $A, B$ . the interactive affection between  $A$  and  $B$  can be seen from function (6). It means that any subsystem's changes will cause changes of the whole system. Under the effect of themselves and external environment, the evolution velocities of two subsystems are respectively:

$$\begin{cases} V_A = dA/dt \\ V_B = dB/dt \end{cases} \quad (7)$$

What can be seen from the above function is that there are only two affected elements of  $f(P)$  and  $f(E)$  in the whole system. So when they intercoordinate, the whole system also develops coordinately. The evolution velocity of interaction coupling system between financial innovation process and financial innovation environment can be seen as the function of  $V_A$  and  $V_B$ , namely  $V = f(V_A, V_B)$ . In this circumstance,  $V_A$  and  $V_B$  can be seen as control variates. The coordinative relation between the whole system and  $f(P)$  &  $f(E)$  will be studied by analyzing the changes of  $V$ .

Solid lines: system reality evolution process;  
Dotted line: the theory of system evolution

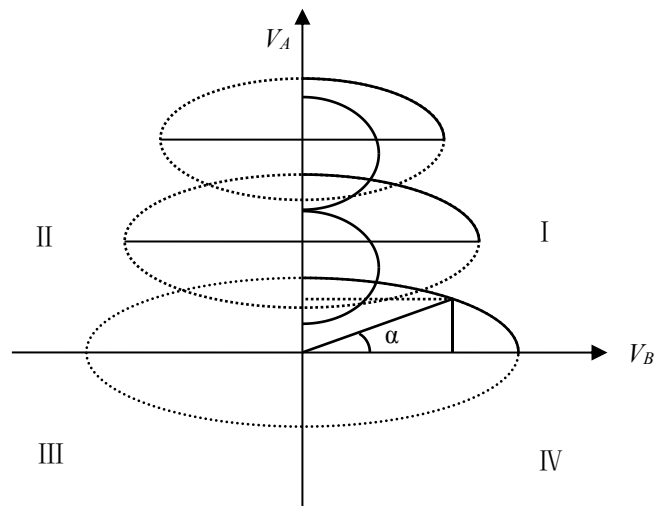


Figure 1. Example of a figure caption.

The evolution mechanism of interaction coupling system between financial innovation process and financial innovation environment meets the type  $N$  development mechanism of combination. Assume that the changes of financial innovation process is periodical, the stress and promotion of financial innovation environment affected by financial innovation process is also periodical. In each cycle, the changes of  $V$  depend on  $V_A$  and  $V_B$ . A simple

model of  $V$  can be established by above analysis. In the two dimensional plane ( $V_A, V_B$ ), the change track of  $V$  is an oval shape. As shown in figure 1.

The angle  $\alpha$  between  $V_A$  and  $V_B$  meets the condition:

$$\text{tg } \alpha = V_A / V_B \quad (8)$$

So the coupling degree is as following:

$$\alpha = \arctan(V_A / V_B) \quad (9)$$

#### IV. ANALYSIS ON THE COUPLING DEGREE OF COUPLING SITUATION

The 2D plane is drawn on to illustrate the coupling degree. As shown in figure 2.

$270^\circ < \alpha < 0^\circ$ , means  $\alpha$  falls into quadrant IV. The development of two subsystems is in a low level coordinative stage. During this period, the development of financial innovation is relatively weak, while the capacity of environment is relatively strong. Financial innovation will not much affect financial innovation environment, and that means the environment is able to carry and digest the influence of financial innovation. At this time, the restraint effect from environment is little and as well as the stress effect from financial innovation.

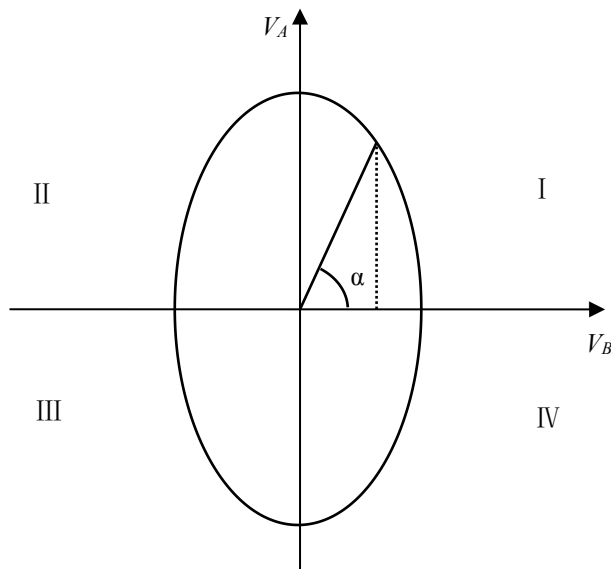


Figure 2. The interactive coupling relationship between two subsystems

$0^\circ < \alpha < 90^\circ$ , means  $\alpha$  falls into quadrant I. The stress role of the fast development of financial innovation playing in environment gradually appears, while the innovation environment has an opposite effect on the financial innovation. the contradiction between two subsystems become visible but not striking. This quadrant can be subdivided into three situations.  $45^\circ < \alpha < 90^\circ$ ,  $\text{tg } \alpha > 1$ ,  $V_A > V_B$ , two subsystems begin interacting and develop mutually to

access to the running-in stage;  $\alpha=45^\circ$ ,  $\text{tg } \alpha=1$ ,  $V_A=V_B$ , it's steady developing stage;  $0^\circ < \alpha < 45^\circ$ ,  $\text{tg } \alpha < 1$ ,  $V_A < V_B$ , to satisfy the need of financial innovation's development, evolving velocity of environment exceed that of financial innovation. Two subsystems begin coupling healthily, and it is improving stage.

$90^\circ < \alpha < 180^\circ$ , means  $\alpha$  falls into quadrant II. It is the middle rapid developing stage of financial innovation. The high speed is increasingly challenging exiting environment so that the contradiction between them is more and more intensified. The largest threshold of environment pressure is reached. This period is antagonism stage.

$180^\circ < \alpha < 270^\circ$ , means  $\alpha$  falls into quadrant III. A spiral type up is shown in this stage. The stress interaction has been broken to rebuild a new relationship which is improving each other so that the whole system reaches a highly coordinative stage.

This paper introduces the principle of coupling situation model and this model is used to study the method of interactive coupling mechanism. According to this method, authors analyze the development trend of interactive coupling between financial innovation and innovation environment and their state pattern rules. At last its trend path and development mode has been analyzed.

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