

# Research On Entrepreneurship Based On The Infectious Disease Model

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**Abstract**—In this paper, an entrepreneurial model with time delay is constructed by using the infectious disease model, and the influence of time delay is analyzed by the simulation, and the critical value of time delay is given here. This paper gives a corresponding explanation to the entrepreneurial model, which is very valuable to improve the success rate of entrepreneurship.

**Keywords**—Enterprising; time delay; success rate

## I. INTRODUCTION

At present, it is very difficult to start a business. How to solve this problem has become the focus of today's society. However, at present, the success rate of starting a business is still very low. This drives us to study the entrepreneurial model, which is of great significance. Although there are different ideas and methods to study entrepreneurship [1-2], they only analyze the existing data and do not form a mathematical model. Therefore, this paper establishes an entrepreneurial model with time delay according to the idea of infectious disease model [3-9]. And carries on the simulation analysis to the establishment model, the result has made the reasonable explanation to the entrepreneurial situation.

## II. CONSTRUCT THE SYSTEM MODEL

First of all, entrepreneurial people are divided into three categories: non entrepreneur people  $U(t)$ , prepared entrepreneur people  $T(t)$  and successful people  $S(t)$ . The model is described as

$$\begin{cases} \frac{dU(t)}{dt} = mS(t) - bU(t) - \beta \frac{U(t)S(t)}{N(t)} \\ \frac{dT(t)}{dt} = \beta \frac{U(t)S(t)}{N(t)} - bT(t) - \delta T(t - \tau) \\ \frac{dS(t)}{dt} = \delta T(t - \tau) - mS(t) \\ N(t) = U(t) + T(t) + S(t) \end{cases} \quad (1)$$

where  $\beta$  represents the knowledge universality degree of entrepreneurship;  $N$  represents the total entrepreneurial people;  $\beta \frac{US}{N}$  is a standard conversion rate of non-entrepreneur people;  $\delta$  present the existing venture capital ratio of people, where  $\delta = \alpha + \gamma$ ;  $\alpha$  represents the national support;  $\gamma$  represents the

investment strength;  $m = 1 - \delta$  is the difference between venture capital maintenance of the required rate of venture capital and existing venture capital ratio;  $\tau$  is time delay of the national support.

Let  $x = \frac{U}{N}$ ,  $y = \frac{T}{N}$ ,  $z = \frac{S}{N}$ , then  $x, y, z$  represent the proportion of  $U(t)$ ,  $T(t)$  and  $S(t)$ . Then the system (1) becomes

$$\begin{cases} \frac{dx(t)}{dt} = mz - bxz - \beta xz \\ \frac{dy(t)}{dt} = \beta xz - byz - \delta y(t - \tau) \\ \frac{dz(t)}{dt} = \delta y(t - \tau) - mz + bz - bz^2 \end{cases} \quad (2)$$

## III. ANALYSIS OF THE MODEL

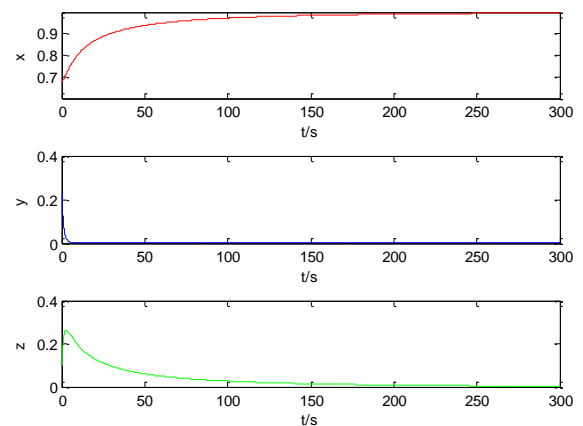


Figure 1 currently the proportion of three sorts of entrepreneurial people

It can be seen from figure 1 that the current situation is in balance, and it is global asymptotically stable. The success rate keeps to zero without fluctuation.

When  $\tau = 0$ ,  $\alpha = 0.03$ ,  $b = 0.18125$ ,  $\gamma = 0.78$ ,  $\beta = 0.01$ , we can get threshold  $R_0 = 0.95394737 < 1$  with  $R_0 = \frac{b}{m}$ , the unsuccessful equilibrium point is obviously exist (see figure 2).

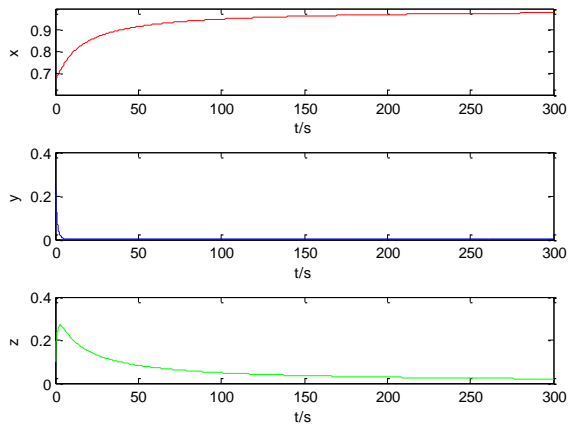


Figure 2 the proportion of three sorts of entrepreneurial people

As we can see in the figure 2, for the now situation, the positive equilibrium point is not exist, that is to say, it is little possible to keep the proportion of entrepreneurial success invariant and only exist unsuccessful equilibrium point. And unsuccessful equilibrium point is unstable with fluctuation as  $b + \delta + \beta = 1.00125 > 1$ . Therefore, this fits the condition that the entrepreneurial success rate is very low and extremely unstable in recent years.

From figures 1-2, we can see that when  $\tau = 0$ , the national support could produce a larger differences on the proportion of the successful entrepreneurs. The current national support is continuously strengthening, and the success rate of entrepreneurship is also not zero. The system (2) also has no cycle phenomenon when  $\tau = 0$ . With the augmentation of the support, the success rate of entrepreneurship also will continue to rise. So the policy support without time delay does not conform to the present situation.

So the policy support with time delay in some cases conforms to the present situation. We take  $b = 0.18125$ ,  $\alpha = 0.02$ ,  $\gamma = 0.78$ ,  $\beta = 0.01$ . Through calculation we can obtain that there only exists the unsuccessful equilibrium point and time delay  $\tau_0^+ = 1.979544233$ . When  $\tau < \tau_0^+$ , the unsuccessful equilibrium point is stable, while it is unstable when  $\tau > \tau_0^+$ .

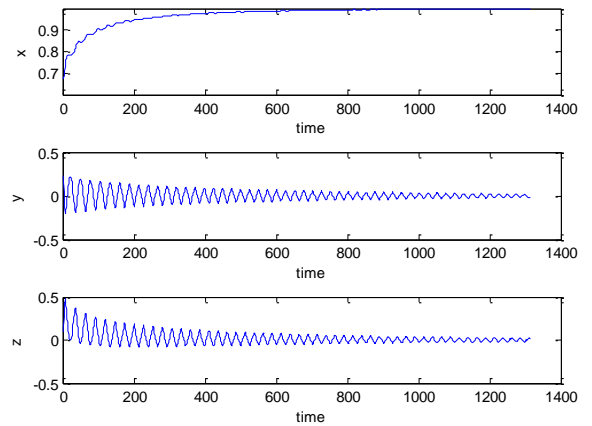


Figure 3 each component and variation of the unsuccessful equilibrium point when  $\tau = \tau_0$

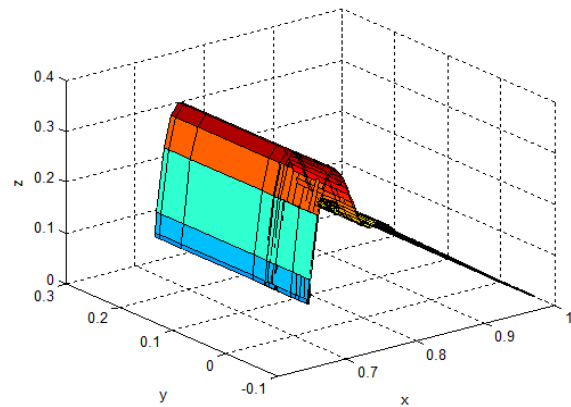


Figure 4 the three-dimensional surface diagram on three sorts of College Students' proportional when  $\tau = 1 < \tau_0$

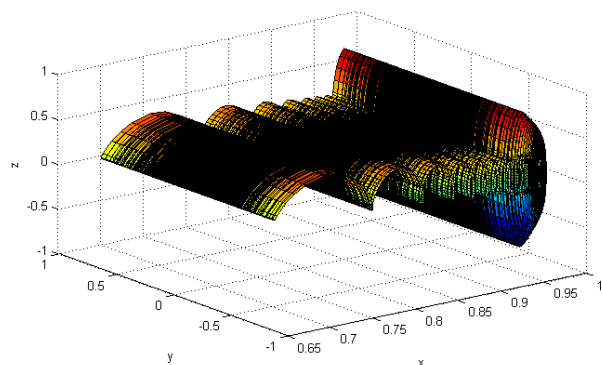


Figure 5 the three-dimensional surface diagram on three sorts of College Students' proportional when  $\tau = 2 > \tau_0$

It can be seen from the above figures 3-5 that when the time delay  $\tau > \tau_0$  of the national support, the unsuccessful equilibrium point is unstable with fluctuation, and produce the periodic solution. However, when  $\tau < \tau_0$ , there is no cycle phenomenon, which reflects that the successful proportion in the current

actual situation fluctuate near zero with cycle. So the success rate of entrepreneurship always fluctuates up and down near zero, which is very accord with the actual situation.

#### CONCLUSION

In this paper, by using the infectious disease model, the entrepreneurial people can be divided into three independent compartments including the non-entrepreneur people, the preparatory entrepreneurs and the successful entrepreneurs. In addition, we established the system model. The national policy support is usually has a time delay. Through calculation, we can obtain the time delay  $\tau_0^+ = 1.979544233$  ; when  $\tau < \tau_0^+$  , the unsuccessful equilibrium point is stable; when  $\tau > \tau_0^+$  . In order to improve the success rate of entrepreneurship, some measures should be taken such as increasing the national support, extending the time of support funds appropriately, applying for the results to dole out money, which is very effective to improve the success rate of entrepreneurship.

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