

Cooperative Behavior Between Imitative Enterprises and Venture Capital on the Perspective of System Dynamics

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ABSTRACT

With the development of Internet industry, new enterprises have sprung up one after another, and many of them are imitative start-ups, for example it came out many firms that made face masks under the pandemic. For most developing countries, small and medium-sized imitative entrepreneurial enterprises have played an indelible role in the country's economic development, bringing the possibility of sustainable development. By the end of China's covid-2019 prevention and control in the first half of 2020, some firms become leading enterprises, while others are facing bankruptcy. There are still some deficiencies in the research on which kind of enterprises a new venture could imitate and when to entry into the market. This paper tries to build a game model between the imitative start-ups and venture capitalist with the help of system dynamics, so as to guide the future sustainable development of the imitative enterprises.

Keywords: *System dynamics, New ventures, Imitative enterprise, Venture capitalist, Game theory.*

1. INTRODUCTION

Under the pandemic many firms that made face masks are were imitative entrepreneurial enterprises. The projected output of face masks in 2020 is more than twice that of 2019, much of this comes from the production of new enterprises. It just is different from each by design, color, size and so on. It contains surgical masks, ordinary gauze masks, industrial dust respirator and daily dust respirator. By the end of China's pandemic prevention and control, some have monopolized the market, some have been acquired, and some have even stopped operating. At present, scholars have studied the development context of imitative entrepreneurship and found that the strategic choice of imitation entrepreneurship has a reference function for independent technological innovation or technology introduction imitation [1, 2]. Based on the life cycle theory, imitative entrepreneurship promotes the generation and evolution of industrial clusters [3]. In the early stages of a business, in uncertain circumstances, the imitative process is considered crucial. Most entrepreneurs will take the most recognized or best business opportunity in their current market, copy the ideas of their predecessors, and then re-implement them

with more advanced technology and a sound value proposition [4], for pursuing low cost and high performance. According to the degree of imitation, direct imitation, concept innovation and product innovation are generally available in the market, that is, there are differences in the degree of imitation innovation [5]. A large part of China's miracle can be attributed to the imitation of entrepreneurial behaviors, using existing developed technologies to produce and thus increase output and profit [6].

Despite the growing literature on imitative entrepreneurship, there is still a lack of in-depth understanding of the study of imitative entrepreneurship. As for how to choose imitation, when to choose imitation, and to what extent, there are few researches on imitative entrepreneurial behavior in China, and the decision-making mechanism of imitative entrepreneurial behavior is not clear. In this paper, the object of study start-up in imitative entrepreneurial companies, for example, by reading a large number of imitative entrepreneurship related literature at home and abroad, based on the theory of game theory, using system dynamics simulation imitative start-ups and venture capitalist cooperation mechanism, as the lately imitative entrepreneurial behavior under the related studies of

work, to guide the imitative entrepreneurial behavior under the Chinese context [7].

2. THEORETICAL BASIS

There are many potential sites for imitative entrepreneurship, such as existing markets, innovative enterprises, venture capitalist, technology symposiums and so on. Existing market. When an actor starts to imitate based on frequency, or based on specific characteristics, and copies the actions taken by a large number of individuals, imitative entrepreneurship follows, due to the temptation of money or profits, including subsidies or facilities provided by the government [7]. Innovative enterprises. Managers or employees of entrepreneurial entrepreneurs, driven by interests or recognition of identity, will choose to leave their original companies and become entrepreneurs by establishing and selling innovative products [8]. Other ways. Technology exchange, venture capital, etc., will lead to the disclosure of innovation information. In order to obtain funds, entrepreneurs may need to disclose the elements of inventions to prospective investors or technical experts, but these investors or experts may be potential imitators [9]. Compared with innovation and entrepreneurship, the more important thing is the project confidentiality. Once disclosed, more imitators and competitors will be born, and the original business plan of the enterprise will be taken away, making the plan fail. The confidentiality of imitative entrepreneurship is even more prudent than that of innovation and entrepreneurship.

Imitate the pioneering enterprise survival than innovation enterprise's development is facing more strict uncertainty, have higher requirements on risk control of Banks and other traditional financial institutions is difficult to imitate for the rapid development of entrepreneurial activities to provide enough financial support [10]. Imitating the success of entrepreneurial behavior and benefits are more difficult to assess than innovation entrepreneurship, in a cycle, the demand of the market is certain, but the same products, alternative products will become more with the imitative start-ups, divide a pie, the more the number of the divided each person share the less. Thus, venture capitalist with the pursuit of high-risk and high-return emerges [11]. Venture capitalist not only provides financial support to start-ups, but also provides professional value-added services in corporate strategy, financial management and other aspects. Compared with bank loans, banks are only responsible for the injection of funds, regardless of the operation and management of enterprises [12]. However, venture capitalist will increase the intervention of modern advanced enterprise management. For the imitative start-ups, risks will be shared by venture investors, which reduces the operational risks of imitative start-ups [13]. The

cooperation between venture capital and imitative start-ups not only solves the problems of lack of capital and advanced management experience in the early stage of the , but also helps the industrialization of advanced scientific and technological achievements and improves benefits of the enterprises. At the same time, it also brings high investment returns to venture capitalist, realizes capital appreciation, and improves the allocation efficiency of social resources. However, the information asymmetry between venture capitalist and imitative start-ups hinders the smooth implementation of this cooperation mechanism, resulting in market failure. Further analysis shows that at different stages of cooperation between venture capitalist and imitative start-ups, information asymmetry brings different governance problems, and the game between the two sides also has different characteristics.

Emulate a lot of potential imitative start-ups, these start-ups are especially need to pay attention to the business plan project of secrecy, but in view of the risk investor confidential blindly, the lack of real information weakens the investor's ability to identify a startup, this will not only enhance the venture capital investment risk, will raise the cost of financing of venture capitalist. They will re-evaluate the necessity of a second investment after the first investment evaluation of a imitative start-ups if nothing is gained. In the context of information asymmetry, this paper only makes game analysis on the first cooperative investment.

3. IMITATIVE EVOLUTIONARY MECHANISM OF ENTERPRISE BEHAVIOR

3.1. Hypothesis

This paper employed evolutionary game theory to analyze the imitative entrepreneurial behavior in the sharing economy. In this paper, the research object of the game model is to imitate the start-ups. Imitative entrepreneurs with innovative start-ups, in seed, the period of start-up may make risk investment can't see the investment demand and value, imitative entrepreneurs are numerous, a product of the enterprises' demand is unpredictable, so this article only to mimic early growth of entrepreneurs and venture capitalist construction of cooperation mechanism game model. When we build the model, we assume that:

(1) Both imitative start-ups and venture capitalists are rational decision makers with the purpose of maximizing their own profits. In the start-up stage, the project financing cannot be realized by imitating the start-ups by relying on their own self-raised funds. The case of sharing bikes is enough to illustrate, so we choose to cooperate with venture capital.

(2) The project that a imitative start-up needs financing, the amount of venture capitalist financing is I , and the expected income of the project at this level is R . There are two possibilities for the funded project: the rate of success of the high imitation mechanism is p , the expected revenue is R_1 , and the probability of success of the low imitative mechanism is $1-p$, the expected revenue is R_2 . In the sharing economy, if the imitative mechanism is very low and there are many competitors, R_2 is likely to be zero. Venture capitalist will inject venture capital I into the imitative start-ups without investigation. The probability of venture capitalist investigation and non-investigation are q and $1-q$ respectively.

(3) The information between the two sides of the game is asymmetric, and the venture capitalist will not get the real information of the imitative startup when choosing concealment information, but the imitative startup can get extra benefit; Venture capitalist can yield real information when the imitator does not hide it, but the total amount of money that the imitator and the venture capitalist share in the benefits. The concealment cost of imitating a start-up enterprise is C_1 , while the venture capital investigation cost is C_2 . If the venture capitalist is investigated, the actual benefit sharing ratio of the project is e_1 . If the venture capitalist is not investigated, the actual benefit sharing ratio of the project is e_2 .

(4) The additional private income obtained by the imitative start-ups after venture capitalist injection is d_1 , such as interest on capital flow, etc.

3.2. Game Analysis of cooperation between new ventures and venture capital

According to the *Hypothesis*, the game payment matrix is established to the cooperative behavior of imitative start-ups and venture capitalist, as shown in Table 1.

Table 1. The game payment matrix

GS	HIM (p)		LIM ($1-p$)	
	CN	NCN	CN	NCN
IN (q)	$e_1R_1 - C_2$ $(1-e_1)R_1 - C_1 + d_1$	$e_1R_1 - C_2$ $(1-e_1)R_1 + d_1$	$-C_2 - I$ $-C_1 + d_1$	$-C_2$ d_1
NIN (q)	e_2R_1 $(1-e_2)R_1 - C_1 + d_1$	e_2R_1 $(1-e_2)R_1 + d_1$	$-I$ $-C_1 + d_1$	$-I$ d_1

Note: Game analysis= GS; Concealment=CN; Non-concealment=NCN; High imitation=HIM; Low imitation=LIM.

As can be seen from Table 1, when imitative startups choose projects with high imitative mechanism, they compare the benefits of imitative startups with those of venture capitalist. Imitative startups add extra cost of concealment, and it is an advantageous strategy to imitative startups to choose no-concealment strategy.

When the imitative start-ups choose projects with low imitative mechanism, the imitative start-ups also increase the cost of concealment, and the imitative start-ups choose not to conceal is the dominant strategy. No matter what kind of imitative mechanism a startup chooses, choosing no-concealment is the dominant strategy.

Regardless of the venture capital choosing investigation or no-investigation, imitative start-ups will get benefits if they choose a high imitative mechanism. If the relationship $ise_1 \leq e_2$, venture capital and imitative start-ups will obtain more incomes. From a venture capital perspective, $e_1 - e_2 \geq C_2/R_1$, venture capital selection survey strategy is the dominant strategy.

In the dynamic game process of "investigation" and "no-investigation" of venture capitalist, and "high imitative mechanism" and "low imitative mechanism" of imitative start-ups, the expected benefit and average benefit of each enterprise are obtained, and the equation is transformed, and the dynamic equation of replication is obtained according to Malthusian.

When imitative start-ups adopt high imitative mechanism strategy, model equation of benefits is as follows:

$$Y_{1a} = q(R_1 - e_1R_1 + d_1) + (1-q)(R_1 - e_2R_1 + d_1) \quad (1)$$

When imitative start-ups adopt the strategy of low imitative mechanism, its benefits are as follows:

$$Y_{2a} = d_1 \quad (2)$$

The average benefit of imitative start-ups is:

$$Y'^a = pY_{1a} + (1-p)Y_{2a} = e_2pqR_1 - e_1pqR_1 - e_2pR_1 + pR_1 + d_1 \quad (3)$$

The replication dynamic equation of the imitative start-ups is:

$$d_p/d_t = p(Y_{1a} - Y'^a) = p(1-p)R_1(e_2q - e_1q - e_2 + 1) \quad (4)$$

When venture capitalist adopts the investigation strategy, the benefit is as follows:

$$Y_{1b} = p(e_1R_1 - C_2) - C_2(1-p) \quad (5)$$

When venture capital adopts the no-investigation strategy, the benefit is as follows:

$$Y_{2b} = pe_2R_1 - I(1-p) \quad (6)$$

The average benefit of venture capital is:

$$Y_b = qY_{1b} + (1-q)Y_{2b} = e_1pqR_1 - e_2pqR_1 + e_2pR_1 - qC_2 - I + qI + pI + pqI \quad (7)$$

The replication dynamic equation of venture capital is:

$$\frac{dq}{dt} = q(Y_{1b} - Y''^b) = q(1-q)(e_1 p R_1 - e_2 p R_1 - pI - C_2 + I) \quad (8)$$

Assume that dp/dt and dq/dt equal to 0, we get the dynamic equilibrium points (0,0), (0,1), (1,0), (1,1), (p^*, q^*) , and

$$p^* = \frac{I - C_2}{R_1(e_2 - e_1) + I} \quad (9)$$

$$q^* = \frac{I - e_2}{(e_1 + e_2)} \quad (10)$$

If it reaches the point (p^*, q^*) , $e_1 - e_2 > C_2/R_1$ and $e_2 - e_1 > 1/21$. Under the same conditions, the proportion of dividends obtained from the venture capital investigation should be greater than the proportion of no-investigation strategy, otherwise there is no need for investigation, that is $e_2 > e_1$.

In the sharing economy, the replication dynamic relationship between imitative start-ups and venture capitalist is shown in Figure 1. The coordinates of point O are (p^*, q^*) , where (0,0) and (1,1) are two evolution-stable strategies of the game between imitative start-ups and venture capitalist.

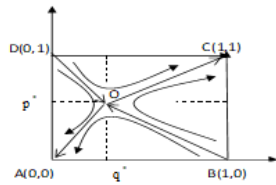


Figure 1 The replication dynamic relationship

(1) when the system converges to point A (0,0), i.e. the initial state is within the range of quadrilateral ABOD, the selection strategy of "low imitative mechanism" of start-ups and "no-investigation" of venture capitalists is imitated. At this point, the probability of p in "high imitative mechanism" of startups and q in "investigation" of the venture capitalist is at least one less than p^* or q^* .

(2) when the system converges to point C (1,1), that is, the initial state is within the quadrilateral BCDO scope, the strategy of "high imitative mechanism" of start-ups and "investigation" of venture capitalist should be selected. At this point, the probability of p in "low imitative mechanism" of startups and q in "no-investigation" of the venture capitalist is at least one larger than p^* or q^* .

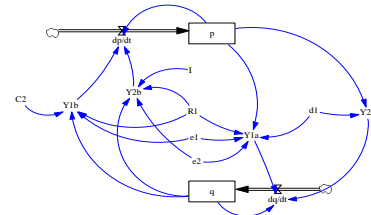
It can be concluded that the initial state determines the direction of system evolution. The polyline BOD is the critical value for the system to converge to (0,0) and (1,1). When the initial state is below the left of BOD, it converges to O (0,0). When the initial state is above the right of BOD, it converges to C (1,1). From the previous analysis, it can be concluded that quadrilateral BCDO is slightly larger than quadrilateral ABOD, which is the

ideal range of analysis. According to Figure 1, the quadrilateral area S of BCDO is:

$$S = 1 - S_{AOB} - S_{AOD} = 1 - 1/2[(I - C_2)/((e_2 - e_1)R_1 + I) + (1 - e_2)/(e_1 + e_2)] \quad (11)$$

3.3 System Dynamics Model

Based on the above analysis, we built a system dynamics model of imitative start-ups and venture



capitalist, as shown in Figure 2.

Based on the above relation, it is assumed that in the initial state, the values of each parameter are as follows: $C_2=0.6$, $I=1.5$, $R_1=1$, $e_1=0.4$, $e_2=0.5$, $d_1=0.5$. According to the evolutionary analysis, by plugging it into the equation (9) and equation (10), $p^*=0.5625$, $q^*=0.5556$. If $0.5625 < p < 1$ and $q=1$, it is an evolutionary stabilization strategy. If $0.5556 < q < 1$ and $p=1$, it is an evolutionary stabilization strategy. Suppose $p=0.6$, $q=0.1$, and the value of q changes at intervals of 0.1, simulate 10 times. Suppose $q=0.6$, $p=0.1$, and the value of p changes at intervals of 0.1, and simulate 10 times. The model was simulated for 20 times in total, as shown in Figure3, Fig 4, Figure 5, Figure 6, Figure7 and Figure8.

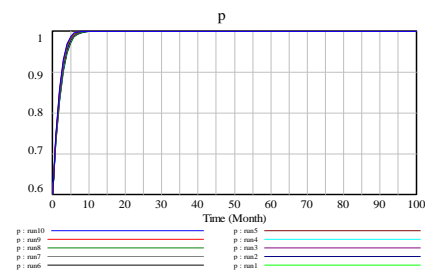


Figure 3 $q=0.6$, the simulation results of p

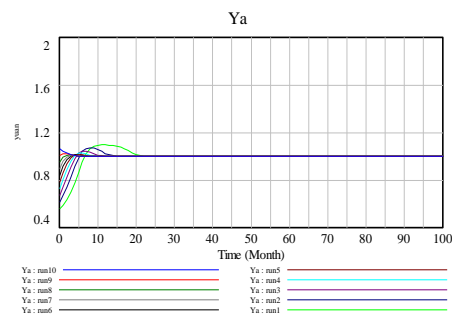


Figure 4 $q=0.6$, the simulation results of Ya

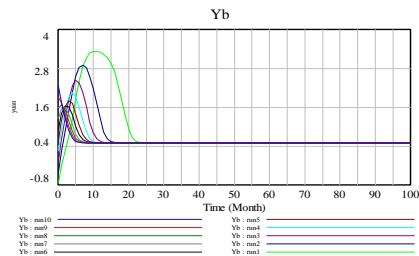


Figure 5 $q=0.6$, the simulation results of Yb

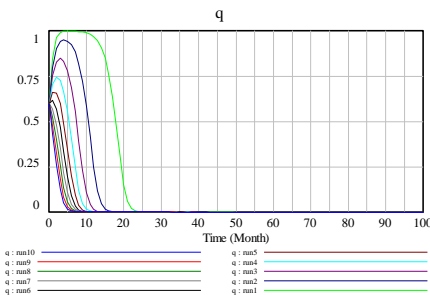


Figure 6 $p=0.6$, the simulation results of q

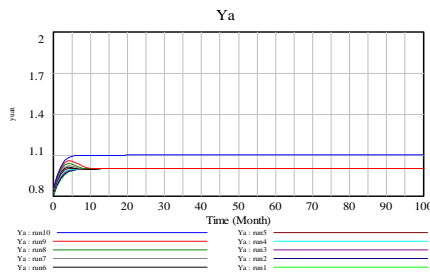


Figure 7 $p=0.6$, the simulation results of Ya

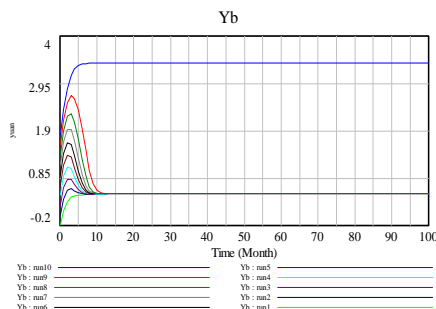


Figure 8 $p=0.6$, the simulation results of Yb

As can be seen from Figures, when q converges to 1 during 10 months, and the speed becomes slower. During the period of "low imitative mechanism" strategy and "investigation" strategy selected by venture capitalist, the maximum benefit of the imitative start-ups can reach 1.09, which is higher than $R1$, while the maximum benefit of venture capitalist can get to 3.34, which is much higher than $d1$. With the increase lifecycle of start-ups, q converges to 0, and the speed is getting faster. The "low imitative mechanism" strategy and the "no-investigation" strategy are adopted by the venture capitalist. During this period, the maximum

benefit of the imitative start-ups can reach 1.1 and finally verges to 1.0, which is close to the initial value $R1$. The benefit of venture capitalist can reach as high as 3.4, and eventually tends to 0.5, which is close to the initial value of $d1$. Thus, it can be seen that under this simulation result, the income and private profit will reach the set initial value when the imitating start-ups choose the strategy of "low imitative mechanism" and the venture capitalist chooses the strategy of "no-investigation".

If $0.6 < p < 1$, q converges to 0 and the speed gets slower. "high imitative mechanism" strategy is chosen by a imitative startup, and "no-investigation" strategy is chosen by a venture capitalist. The benefits of imitative start-ups gradually rise, changing from 0.8 to 1.1. The benefits of venture capitalists decrease from 2.2 to 0.5 gradually. Under the simulation results, there exists an inverse relationship between the benefits of imitative start-ups and venture capitalist.

And similarly analytically, when the initial value of p equals to 0.6, with the gradual increase of value q , the change of value p is very small and can converge to 1 in the first 10 months, that is to say, imitative start-ups select strategy of "high imitative mechanism" and venture capitalist selects strategy of "investigation". It can be seen from Figure6 that, when $0 < q < 0.9$, in the first 3 months before starting a business, both the benefits of the imitative start-ups and venture capitalist show a trend of gradual increase. The range of benefits of the imitative start-ups is from 0.8 to 1.058, while that of venture capitalist is from -0.198 to 2.68. With the increase of start-ups' time, the benefits of imitative start-ups and venture capitalist start to decline, and finally tend to 1.0 and 0.5 respectively. When $q=1$ and $p=1$, that is, imitative start-ups would choose strategy of "high imitative mechanism" and venture capitalist would choose strategy of "investigation". In the first five months of starting a business, the benefits of imitative start-ups rise from 0.8 to 1.1, while these of venture capitalist rise from 1.8 to 3.4.

4. CONCLUSION

When an imitative startup chooses a project with a high imitative mechanism, it compares the benefits of an imitative startup with that of a venture capitalist, and the imitative startup adds extra cost of concealment. It is an advantageous strategy for an imitative startup to choose no-concealment. When the imitative start-ups choose projects with low imitative mechanism, the imitative start-ups also increase the cost of concealment, and choosing no-concealment is the dominant strategy. No matter what kind of imitative mechanism a startup chooses, choosing no-concealment is the dominant strategy.

The ultimate goal of the game between imitative start-ups and venture capitalist is to achieve equilibrium state and obtain higher benefit. In the existing market, no matter what kind of imitative mechanism is been chosen, the imitative start-ups can obtain certain benefits. For a venture capitalist, the "investigation" strategy should be adopted in order to obtain higher benefits. Through the above analysis, it can be found that "low imitative mechanism" strategy adopted by the imitative start-ups and "no-investigation" strategy adopted by the venture capitalist will promote the increase of double sides' benefits within 10 months, both of which are higher than expected values. Therefore, for double sides of the game, in the sharing economy environment, the level of informatization becomes high and information travels fast.

Venture capitalist must make financing decisions within a short period of time, provide financial support, participate in imitating the operation management of start-ups, increase technical support, quickly imitate the products or services of existing enterprises in the market again, and gain sale shares again. Although we study the relationship of the imitative start-ups and venture capitalist, but is also applies to the relationship between the civil enterprises and the military. Because of the particularity of military work, if the civil and the military reach cooperation, they should mutually keep in secret. The military needs to strictly investigate civilian enterprises output and the operation status, civilian enterprises should not conceal anything. However, what cooperation status between civilian enterprises and the military departments can achieve win-win results and is worthy of further discussion.

AUTHORS' CONTRIBUTIONS

Conceptualization, Bingbing Li; methodology, Bingbing Li; software, Bingbing Li and Xiaofen Zhou; writing—review and editing, Bingbing Li; visualization, Bingbing Li; supervision, Xiaofen Zhou. All authors have read and agreed to the published version of the manuscript.

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