Simulation Study on the Influential Effect of Venture Capital Decision-making Behavior’s Influencing Factors

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Abstract. Based on MOTAD model and research data of 605 investment projects of 156 venture capital investment institutes in Zhejiang Province, China, during 2009~2011, this paper simulates investment decision-making behaviors and changes in different scenarios, reveals the influence effect of influence factor such as size of fund and tax changes on their investment decision-making behaviors, and further uncovers internal mechanism reflected by investment decision-making behaviors of venture capital investment institutes. At last, the paper combines with simulation conclusion and brings forward relevant policy suggestions.

Introduction

Venture capital is an investment behavior that provides equity capital for an immature venture company, provides management and operation service, and expects to get huge medium and long-term earnings through equity transfer after the company becomes relatively mature; therefore, this is an important capital strength to propel entrepreneurship and innovation[1]. However in recent years, venture capital investment in China has concentrated on enterprises at growth stage and mature stage; proportion of projects and amounts of investment in start-up enterprises is still not high, which hinders the development of potential start-up enterprises, but also weakens the support and incubation function of venture capital investment in start-up enterprises[2]. Therefore, it is extremely important to further study influence effect of influence factors on investment decision-making behavior of venture capital investment institutes in start-up enterprises, and thus provide theoretical basis for the government to formulate policies to propel venture capital investment institutes’ investment in start-up enterprises.

In existing domestic and foreign literature, scholars at home and abroad have studied investment decision-making behavior of VC investment institutes from different angles and with different methods. Most domestic studies pay attention to influence factor of decision-making behavior of VC investment institutes, but neglects the influence effect of their changes on investment decision-making behavior of VC investment institutes[3,4]. Regarding research method, existing studies mostly adopt qualitative or index system evaluation method; multi-objective programming optimization model used by some scholars depicts investment decision-making behavior in a relatively scientific way, but neglects the effect of investment risk on investment decision-making behavior, nor considering the effect of policy factor[5]. In my opinion, it is necessary to break through existing research thought and method, refer to international avant-guard MOTAD (Minimization of the Total Absolute Deviations Model) model method, and thus improve scientificity and practical application value of research results.

Influence Effect Simulation of Influence Factor of VC Decision-Making Behavior

Build MOTAD Model

According to expected utility theory, a decision-maker selects according to maximum expected utility[6]. This paper adopts risk decision model—Minimization of Total Absolute Deviations
Model (MOTAD) to simulate investment decision-making behavior of VC investment institutes in different scenarios, and discuss the effect of “different capital scale” and “tax preference” on VC investment decision-making behavior.

Model Building and Mathematical Expression. VC investment project performance varies with policy environment, operation management, technological development and market prospect, which is expressed by earning fluctuations. Under the same expected earnings, if VC investors’ earnings fluctuate greatly, it means that VC institutions face greater risks. Similarly, within certain fluctuation range of earnings, the higher expected earnings the VC investors have, the less risks the VC institutions undertake.

In MOTAD model, investment risk level of the VC institutions is quantized with two indexes. One is TAD (Total Absolute Deviation), and the other one is MAD (Mean Absolute Deviation). As linear replacement form of quadratic programming model, MOTAD model consists of two parts: objective function and constraint condition. Objective function is to minimize investment project risk, in order to realize certain earnings. Constraint condition mainly includes capital scale, venture investment earning deviation and project investment quota of VC institutions. Mathematical expression of MOTAD model is as follows:

$$\min \sum_{t=1}^{s} Y_t^- = \min - \sum_{t=1}^{s} (\sum_{k=1}^{n} (Q_{tk} - \bar{Q}_k)x_k), Q_{tk} \leq \bar{Q}_k$$ (1)

s.t. \[ \sum_{k=1}^{n} (Q_{tk} - \bar{Q}_k)x_k + Y_t^- \geq 0, (k = 1,2,...,n), (t = 1,2,...,s) \] (2)

$$\sum_{k=1}^{n} \bar{Q}_k \cdot x_k = \varphi$$ (3)

$$\sum_{k=1}^{n} x_k \leq B_i, (i = 1,2,...,m; k = 1,2,...,n)$$ (4)

$$x_k \leq A_i B_j$$ (5)

$$x_k, Y_t^- \geq 0$$ (6)

Formula (1) is an objective function to pursue TAD minimization or MAD minimization of total earnings of all actually invested VC projects. That is, realize risk minimization. In Formula (1) objective function, \(Q_k\) represents unit expected gross profit of no. k VC investment project; \(Q_{tk}\) represents investment earnings at t year of no. k VC investment project; \(x_k\) represents investment amount of VC institute in no. k VC investment project. Formula (2) to (6) represent different constraint conditions: Formula (2) represents earning deviation constraint; in a natural state, earning deviation of all investment projects of VC institute is no less than \(Y_t^-\); \(Y_t^-\) represents the sum of absolute value of absolute deviation that actual earning level of investment projects in t year is less than average level of the sample. Formula (3) represents expected earning constraint, total expected earnings of all investment projects of VC institutes, which belongs to earning parameter. After determining original value of parameter \(\varphi\), carry out sensitivity analysis on \(\varphi\), and thus determine a series of corresponding expected earning constraint. B in Formula (4) represents restraint of total investment amount of VC institutes, whereas \(i\) means limiting value of resource constraint, representing total capital of no. i VC institute that can be used in project investment. Formula (5) represents constraint of investment amount available to every investment project. To different total investment \(B_i\), corresponding \(A_i\) value changes. Formula (6) represents constraint of nonnegative sum of absolute value of project investment amount and absolute deviation.

Mathematical expression of MOTAD model has been explained above. The following part will
analyze and determine some parameters in MOTAD model.

1. \( \overline{Q}_k \) in Formula (1) objective function represents unit expected earning of VC projects, which is usually calculated according to average earnings of the project in the past years. Since it is difficult to gather relevant data, average expected earning of the industry in Zhejiang Province is adopted instead.

2. \( (Q_k - \overline{Q}_k) \) in Formula (1) objective function represents annual earning deviation coefficient of VC project, which is the difference between actual unit earning and unit expected earning of VC project. Earning deviation coefficient is calculated through risk level quantification of detailed data of 605 investment projects of 156 VC institutes in Zhejiang Province during 2009–2011, including investment amount, annual profit rate and unit investment earnings.

3. Formula (5) in MOTAD model is called diversified constraint. With expert investigation method, \( A_i \) value is determined by soliciting experts’ opinions and communicating for many times.

**Solution Procedure.** It is inferred from the structure of MOTAD model that its solution shall be vector quantity, represented with the set of \( (x_1, x_2, \ldots, x_n; Y_1-, Y_2-, \ldots, Y_s-) \). Specific solution procedure of MOTAD model is as follows:

**Step 1:** firstly, solve maximum expected earnings under non-risk condition. That is to say, the first \( \phi \) value in the second Formula (3) in MOTAD model can be determined by solving a determination model, whose objective function is earning maximization. Take simplified MOTAD model as an example, determination model, whose objective function is earning maximization purely, consists of Formula (3) to Formula (6) in MOTAD model, transforms Formula (3) into objective function and adjusts Formula (6) properly. Specific model form is as follows:

\[
\max E = \sum_{k=1}^{n} \overline{Q}_k x_k \tag{7}
\]

\[
\text{s.t. } \sum_{k=1}^{n} x_k \leq B_i, (i = 1, 2, \ldots, m) \tag{8}
\]

\[
x_k \leq A_i B_i \tag{9}
\]

\[
x_k \geq 0 \tag{10}
\]

According to determination model whose objective function is earning maximization, solve maximum expected earning \( E_0 \) under existing resource constraint, and solve investment scale of every project corresponding to maximum expected earnings, which is the value of \( x_k \) (k=1, 2, \ldots, n).

**Step 2:** maximum expected earning \( E_0 \) in Step 1 is regarded to be the first earning value under risk condition (indicated as \( E_1 \)), which is the first value of earning parameter. It is substituted into Formula (3) in MOTAD model; by model operation, obtain \( x_k \) (k=1, 2, \ldots, n), \( Y_t(t=1, 2, \ldots, s) \) and negative total absolute deviation (TAD/2). According to formula \( \text{MAD} = \text{TAD} / S = (1 / S) \cdot \sum_{t=1}^{s} Y_t^- \), solve the first corresponding MAD, which is risk level corresponding to expected earning level \( E_1 \). In this way, solve the combination of earning (\( E_1 \)) and risk (\( \text{MAD}_1 \)) of the first group, as well as optimal scale of every investment project under this risk earning level.

**Step 3:** while solving above MOTAD model, carry out sensitivity analysis and obtain the maximum allowable reduction while keeping optimal basis unchanged. In accordance with sensitivity analysis result, determine the second value of earning parameter in MOTAD model, which is the second earning level under risk condition (\( E_2 \)).

**Step 4:** the second value of earning parameter obtained through sensitivity analysis is substituted into MOTAD model. Repeat Step 2 to obtain combination of \( \text{MAD}_2 \) and \( E_2 \) (risk earning), and corresponding optimal investment scale.

**Step 5:** Repeat Step 3 and Step 4, until sensitivity analysis result shows that earning parameter \( \phi \)
is 0, or earning level cannot be reduced further, or no solution is obtained after \( \varphi \) is substituted into MOTAD model.

Through above steps, obtain a series of relevant combination of MAD (risk level) and E (risk earning), and corresponding optimal scale of every investment project \( x_i \).

It is noted that MOTAD model is calculated with LINGO software. Field investigation document shows that most VC institutes no longer consider investing in start-up enterprises, if total expected earning is lower than 8% of annualized earning. Therefore, during solution, calculation is stopped when sensitivity analysis result shows that \( \varphi \) value is less than 8% of annualized earning.

**Simulation Study Based on MOTAD Model**

**Design of Simulation Scenario.** Through literature review and investigation of VC institute, it is found that capital scale of VC institute and tax policy of the government affect VC institute’s decision to invest in start-up enterprises, but literature doesn’t expound how much influence effect it will be. Therefore, this paper selects different capital scales and exemption from 6% value-added tax to be new simulation scenarios of MOTAD model.

**Scenario of Different Capital Scales.** Three capital scales are used to simulate the influence effect of investment capital change on the decision-making behavior of VC institute. Three capital scales are selected according to field investigation: capital scale A (RMB 380 million Yuan) is a large-scale capital, capital scale B (RMB 200 million Yuan) is a medium-scale capital, and capital scale C (RMB 80 million Yuan) is a small-scale capital.

**Scenario of Exemption from 6% Value-added Tax.** VC investment development cannot do without tax policy support, so expected investment earning of VC institute is closely related with governmental tax. At present, main form of VC institute is equity investment partnership. In practice, since China implements the policy of replacing business tax with value-added tax, besides 6% value-added tax, partnership VC institute also has to pay 35% individual income tax. Compared with 20% tax of personal investment, this tax is obviously heavier and seems unfair. This tax policy encourages VC investors to turn to personal investment, which contradicts share partnership encouraged by the country. Therefore, combining improvement direction of China’s tax and tax policies in foreign countries with developed VC investment, this paper designs the following scenario of tax preference policy:

Tax policy pertinent to equity investment partnership is exemption of 6% value-added tax, and individual income tax is set to be 25%. As a result, calculation of annual rate of return on investment has changed in VC institute. Since VAT changes from 6% to 0% and individual income tax rate changes from 35% to 25%, unit expected earning and deviation coefficient of VC institute in the past years have changed correspondingly.

**Analysis on Simulation Result of MOTAD Model.**

**Analysis on the Effect of Different Capital Scales on VC Investment Decision-making Behavior.** Based on MOTAD model, simulation result of VC institutes’ decision to invest in start-up enterprises under three capital scales is shown in Figure 1: seen from decision-making behavior of MOTAD model under three capital scales, VC institutes face different risk earning levels under different capital scales. Generally speaking, the larger capital scale the VC institutes hold, the higher earning level they will obtain, but the higher risk level they will undertake. In contrary, the smaller capital scale the VC institutes hold, the lower earning level they will obtain, and the lower risk level they will undertake. Under the same risk level, the larger capital scale the VC institutes hold, the higher earning level they will obtain. Therefore, by increasing investment capital under the same risk level, their earning level will be enhanced, which promotes VC institutes’ investment in start-up enterprises.
Analysis on the Effect of Governmental Tax Policy on VC Investment Decision-making Behavior. Simulation result of MOTAD model is shown in Figure 2. In case of exemption of 6% value-added tax, VC institutes’ investment earnings are higher than that in case of collection of 6% value-added tax. It clearly displays that under the same risk level, exemption of 6% value-added tax increases VC institutes’ expected earnings, and they are more willing to invest in start-up enterprises.

Policy Suggestions
Simulation of MOTAD model has displayed that exemption of 6% value-added tax exerts great positive effects on decision-making behavior of VC institutes; tax reduction and exemption mobilizes VC institutes’ enthusiasm of investment in start-up enterprises. This conclusion coincides with practical experience of policy in foreign developed regions.

To promote VC institutes to increase investment in start-up enterprises, it is suggested that: 1. 6% value-added tax should be exempted. 2. Profit obtained by VC institutes from investment in start-up enterprises can deduct tax amount in proportion to investment amount. 3. Support development of one industry, promise that all profits obtained by VC institutes from investment in start-up enterprises in the industry can be exempted from value-added tax or can deduct tax amount in proportion to investment amount. 4. In order to expand capital scale of VC institutes, tax incurred from profit obtained by VC institutes from investment in start-up enterprises can be deferred or exempted.

According to simulation result of MOTAD model, the larger capital scale the VC institutes hold, the higher earning level they will obtain, so increasing capital scale managed by VC institutes helps to promote their investment in start-up enterprises. Therefore, it is recommended that the government should increase capital scale managed by VC institutes in a direct or indirect way, propel VC institutes’ investment in start-up enterprises and regulate their investment industry properly. Detailed suggestions are as follows: 1. When VC institutes invest in start-up enterprises recognized by the government, the government follows the investment. 2. When VC institutes invest in start-up enterprises, the government subsidizes to a certain extent. 3. When VC institutes invest in start-up enterprises supported by the policy, withdraw risk provision in proportion to investment amount of VC institutes, in order to compensate losses of VC institutes in case of investment failure. 4. The government injects capital into VC institutes in way of low-interest-rate
loan, so as to help them to finance. Meanwhile, encourage more private capital to go into VC institutes.

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