Study on the Guiding Effects of the Government Venture Capital Guiding Fund Based on Markowitz Mean-Variance Model

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Abstract. With the implementation of innovation and entrepreneurship development policy, the government venture capital guiding fund has shown a trend of explosive growth in recent years. To study whether the government has a good policy effect on the venture capital market after setting up the guiding fund and how to guide the policy effect of capital, that is whether to guide the social capital into venture capital enterprises after government has set up the guiding fund, turns to be significant. In this paper, we had been used Markowitz Mean-Variance Model to analyze the optimal portfolio selection of the Market participants before and after government established the guidance fund. The results show that after government set up a guiding fund, the capital supply of venture capital market will be increased. This mechanism is achieved by influencing the expected benefits and risks of investors.

1. Introduction

With the development of technology, venture capital has played an indispensable role in innovation and development. Today, the Government Entrepreneurship Guide Fund has rapid development, which is no longer limited to expanding the fund supply of venture capital, and gradually turned to the role of its guiding effect. As a new thing, our country decided to flourish the government venture capital guiding fund. At the same time, more and more problems has been happened. Which makes the research of the government venture capital guiding fund has become an important study topic.

Research of the government venture capital investment fund research is mainly from the establishment of operation mode, reduction of "market failure" and the establishment of incentive mechanism under the principal-agent problem. Venckuviene, Vitalija1, Snieska, Vytautas (2014) was pointing out that when the government promotes the development of venture capital funds, then also promotes the development of small and medium-sized enterprises through technological innovation, so as to form a virtuous circle of venture capital [1]. Guo-ping Shi (2016) pointed out that the guidance fund can guide non-state-owned venture capital firms to early enterprises [2]. Min-li Yang (2015) pointed out that after the establishment of the government guidance fund, the number of venture capital firms, venture capital institutions and limited partners entering the venture capital market for the first time have been significantly higher than those of the cities without the establishment of the guidance fund [3]. Xiu-hui Chen (2016) pointed out that the violation of laws and regulations of the punishment, the government's supervision costs and regulatory efficiency, the government's financial support and other factors will have a certain impact on the equilibrium probability of the game [4].

Based on the above analysis, we find out that domestic scholars have not made a mathematical analysis of the guiding effect, and have not yet analyzed the guiding mechanism of the government venture capital guiding fund from the perspective of financial economics. Based on the above
thinking, this paper attempts to make a deep study of the formation mechanism of the guiding effect of venture capital funds.


2.1 Basic assumptions

H1: Participants: There are two types of investors in the market, venture capital institution, general investor. Participant’s choices of the investment based on the information provided in the market and the individual risk appetite.

H2: Alternative investment assets: There are risk assets and general financial assets in the pre-fund market. After the establishment of the guidance fund, the market has increased the government guide funds involved in the investment of neutral assets.

H3: Investable market: Based on the choice of investable assets, there is a general investment market and venture capital market before setting up the guiding fund. The establishment of the guiding fund in the market has increased the risk-return neutral market.

H4: Participant's behavior choice and preference specification: Assume that the general investor and the venture investor form the basic expectation \(E(r_i, I)\), \(\sigma_i^2\) according to their own "information set" and then combined with their investment preferences \(\rho_i\) conduct behavior choice, where the income is assumed to be the expected return, the risk is expressed by variance. The benefits and risks of the two types of investors has be shown in Table 1.

<table>
<thead>
<tr>
<th>Investor initial wealth (W_i^0)</th>
<th>General financial assets (R)</th>
<th>Sub-funds (G)</th>
<th>Venture capital assets (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected (E(r_i, R))</td>
<td>Expected (E(r_i, G))</td>
<td>Expected (E(r_i, V))</td>
<td>Expected (E(r_i, V))</td>
</tr>
<tr>
<td>variance (\sigma_i^2)</td>
<td>variance (\sigma_i^2)</td>
<td>variance (\sigma_i^2)</td>
<td>variance (\sigma_i^2)</td>
</tr>
</tbody>
</table>

Generally speaking, the average investor thinks that the income of the general financial assets is less than that of the risky assets, but the risk level is far smaller than the risk of venture capital, but the opposite is true for the venture capitalists. After the government set up the sub fund, it is further assumed that the expectations and variances formed by the two types of investors are comparable according to their own risk preferences and subjective utility levels, and the specific form is as follows:

\[
\begin{align*}
E(r_{R,R}) &< E(r_{R,G}) \ll E(r_{R,V}) \\
\sigma_{R,R}^2 &\approx \sigma_{G,R}^2 \ll \sigma_{V,R}^2 \\
E(r_{V,R}) &< E(r_{V,G}) \approx E(r_{V,V}) \\
\sigma_{V,R}^2 &\approx \sigma_{V,G}^2 \ll \sigma_{V,V}^2
\end{align*}
\]

(1) (2)

2.2 The construction of the model

Firstly, the investor arranges the asset according to the information set. The weight of the general financial asset is \(W_R\), the weight of the risk asset is \(W_V\), the weight of the investment fund is \(W_G\), and according to the assumption, the general investors can invest in assets from the general financial assets and sub-fund composition, so for the general investor's asset allocation has the following formula:

\[W_R + W_G = 1\]

(3)
Second, investors form the basic expectations of the two types of assets based on their basic
information and preferences, and measure the risks with expectation. General the expected return
of financial assets for the \( E(\mathcal{R}) \), variance of sigma \( \sigma^2 \), and the expected return for risky assets \( E(\mathcal{V}) \), variance of sigma \( \sigma^2 \), sub funds expected return for \( E(\mathcal{G}) \), variance of sigma \( \sigma^2 \). To distinguish
general investor and venture investor's portfolio expectation and variance, still adopt the method of
the front, before a lowercase word now mark types for the investors, said after a small scale
portfolio \( p \). According to the portfolio theory, the expected return and variance (risk) of the general
investor portfolio can expressed as the following formula:

\[
\begin{align*}
\text{MAX } S_{\mathcal{R},\mathcal{P}} &= \frac{E(\mathcal{R},\mathcal{P}) - r_f}{\sigma^2_{\mathcal{R},\mathcal{P}}} \\
E(\mathcal{R},\mathcal{P}) &= \mathcal{W}_R \cdot E(\mathcal{R}) + \mathcal{W}_G \cdot E(\mathcal{G}) \\
\sigma^2_{\mathcal{R},\mathcal{P}} &= \mathcal{W}_R^2 \cdot \sigma^2_R + \mathcal{W}_G^2 \cdot \sigma^2_G + 2\mathcal{W}_R \cdot \mathcal{W}_G \cdot \text{Cov}(\mathcal{R},\mathcal{G}) \quad (7)
\end{align*}
\]

\( \mathcal{W}_R + \mathcal{W}_G = 1 \) \hspace{1cm} (4)

Similarly, for investors, because the government venture capital fund of the fund as a special
asset, while investment in the field of venture capital, but it belongs to the policy of the fund, but
the risk, income and investment assets don't want to close, so the combination of the expected
return and variance can be expressed as the following form:

\[
\begin{align*}
\text{MAX } S_{\mathcal{V},\mathcal{P}} &= \frac{E(\mathcal{V},\mathcal{P}) - r_f}{\sigma^2_{\mathcal{V},\mathcal{P}}} \\
E(\mathcal{V},\mathcal{P}) &= \mathcal{W}_G \cdot E(\mathcal{G}) + \mathcal{W}_V \cdot E(\mathcal{V}) \\
\sigma^2_{\mathcal{V},\mathcal{P}} &= \mathcal{W}_G^2 \cdot \sigma^2_G + \mathcal{W}_V^2 \cdot \sigma^2_V \quad (6)
\end{align*}
\]

3. Extended Model Solving and Analysis

Since the government has not established a guidance fund, the solution process is relatively
simple. Therefore, we had given the analysis process of optimal portfolio of participants after the
government sets up a guidance fund.

3.1 The optimal risk portfolio of the general investor

The optimal portfolio of risk assets for general investors can be expressed as follows:

\[
\begin{align*}
\text{MAX } S_{\mathcal{R},\mathcal{P}} &= \frac{E(\mathcal{R},\mathcal{P}) - r_f}{\sigma^2_{\mathcal{R},\mathcal{P}}} \\
E(\mathcal{R},\mathcal{P}) &= \mathcal{W}_R \cdot E(\mathcal{R}) + \mathcal{W}_G \cdot E(\mathcal{G}) \\
\sigma^2_{\mathcal{R},\mathcal{P}} &= \mathcal{W}_R^2 \cdot \sigma^2_R + \mathcal{W}_G^2 \cdot \sigma^2_G + 2\mathcal{W}_R \mathcal{W}_G \cdot \text{Cov}(\mathcal{R},\mathcal{G}) \\
\mathcal{W}_R + \mathcal{W}_G &= 1
\end{align*}
\]

To analyze the range of \( \mathcal{W}_R^* \), it is necessary to analyze the situation of A and B. The following
will analyze the numerical characteristics of these two expressions:

For A we know that the sub-fund of the government venture capital guidance fund not only
combines the benefits and risks of the general financial assets, but also combines the guidance fund,
so for \( \rho_{\mathcal{R},\mathcal{G}} \) must have \( \rho_{\mathcal{R},\mathcal{G}} \in (0,1) \). And it can be deduced from the hypothesis (5)[ \( E(\mathcal{G}) - r_f \) >
\( E(\mathcal{G}) - r_f \) > 0, then A > 0 holds; and B > 0 holds.

\[
\lim_{E(\mathcal{R})=E(\mathcal{G})}(A - B) = \rho_{\mathcal{R},\mathcal{G}} = \frac{[E(\mathcal{R}) - r_f]}{[E(\mathcal{G}) - r_f]} = \rho_{\mathcal{R},\mathcal{G}} - 1 < 0
\]

From the above analysis it can be concluded that 0<A<B is established, so there is
\[ W^*_R = \lim_{\sigma^2_{R \to \sigma^2_{G}}} \frac{1 - \frac{\mathbb{E}(r_R - r_f)}{\mathbb{E}(r_G - r_f)} \times \rho_{R,G}}{(1 - \rho_{R,G}) \left( 1 + \frac{\mathbb{E}(r_R - r_f)}{\mathbb{E}(r_G - r_f)} \times \sigma^2_{R} \right)} = \lim_{\sigma^2_{R \to \sigma^2_{G}}} \frac{A}{B} = C \]  

(11)

\[ W^*_{r,G} = 1 - W^*_R \]

In this equation, \( C \in (0,1) \) and \( W^*_{r,G} \in (0,1) \).

3.2 The optimal risk portfolio of venture capitalists

According to the basic assumptions and the general investors' solution method, the optimal portfolio of venture investors can be solved as follows:

\[
\begin{align*}
W^*_V &= \lim_{\sigma^2_{R \to \sigma^2_{G}}} \frac{\mathbb{E}(r_V - r_f)}{\mathbb{E}(r_G - r_f)} \times \sigma^2_{V} = 0 \\
W^*_G &= 1 - W^*_R
\end{align*}
\]

(12)

Based on \( \sigma^2_{V,G} \ll \sigma^2_{V,V} \), the optimal investment strategy for investors is all of the funds invested in government funds to guide the sub fund for direct investment in risky assets is 0.

3.3 Model results analysis

Based on the solution of the basic and extended models, the optimal portfolio of risk investors and the combination of the general investors and the venture investors were summarized as Table 2:

<table>
<thead>
<tr>
<th>Investor type</th>
<th>General investors</th>
<th>Venture capitalists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>after</td>
</tr>
<tr>
<td>General financial assets</td>
<td>1</td>
<td>C</td>
</tr>
<tr>
<td>Sub-funds(G)</td>
<td>0</td>
<td>1-C</td>
</tr>
<tr>
<td>Venture capital assets(V)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: C is a constant. \( C \in (0,1) \).

4. Conclusion and Recommendation

Through the above analysis we can see that although the government set up a venture fund after the establishment of venture capital from direct investment to indirect investment, but the final capital will invest in start-ups, so there is no risk investors "crowding out", but a transfer of investment. However, for the normal investors, it has played a significant role in guiding. Therefore, the comprehensive point of view, the Government setting up a guide fund does play a guiding role for investors; this guiding effect is conducive to improving the venture capital market capital supply. In addition, the supply is actually equal to the sum of the funds invested by the average investor on the sub-fund.

Based on the above conclusions, China's regional government guiding the large-scale establishment of the Fund in recent years is in line with the law of market development, which is a correct policy. Therefore, each region must play the guiding role in the process of development of venture capital fund in support of the local area of innovation and entrepreneurship, and with the appropriate design on the risks and benefits of guiding fund to support the project. By means of changing the basic premise expectation of the market participants, we can guiding capital investment guidance funds to play a better field in innovation and entrepreneurship.

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6. References


