Evolutionary Game Theory and the Stock Market Investment Behavior

YIMING ZHAO

ABSTRACT

From the perspective of evolutionary game theory, this paper studies the behavior of individual investors in the stock market and its influencing factors. On the basis of the traditional stimulus-reaction dynamic model, multiple linear regression analysis was introduced, and the OLS model was constructed, and the data of Chinese family financial survey (CHFS) was returned. The results show that in the numerous factors that affect individual investors return on investment, level of education has significant positive effect on stock returns, risk attitude and occupational factors are relatively weak, and the investment strategy, there is no significant impact on investment returns.

INTRODUCTION

In the last decade, the share market participation of Chinese households has risen sharply, and the role of individual investors in the stock market fluctuation has become more and more important. It is a popular issue in academia to analyze and explain the influencing factors that affect the investment income of individual investors. Because of the hypothesis of rational expectations, traditional classical game theory cannot answer this question very well. Evolutionary game theory argues that individual investors are not perfectly rational in investing in the stock market, and investors' personal characteristics and environment will influence their investment strategies. According to classic investment theory, risk income is an important component of investment income, and how to identify and treat risks, and to a large extent determine the investment income of individual investors. The traditional economic theory mainly analyzes this problem from the perspective of the basic characteristics of individuals and families, and explains it through factors such as personality characteristics, risk preference and family economic foundation. This article from the perspective of individual level of education that investment to analyze the personal and family problems, from the point of impact on the way, in addition to focus on individual risk tendency, also from the perspective of job characteristics are analyzed.

LITERATURE REVIEW

Many scholars at home and abroad have conducted in-depth researches on the problem of evolutionary game theory and stock market investment income. The direction of research can be divided into two categories: one is the discussion on the theory of evolutionary game theory, and the other is the analysis of the problems in the application process of evolutionary game theory.

Yiming Zhao, Guangxi normal university affiliated foreign language school, No.10, zishan road, qixing district, guilin, guangxi, China
Zhang Liangqiao and other scholars studied the theoretical basis of evolutionary game theory from the perspective of classical game theory and evolutionary game theory. Zhang Liangqiao (2001) in his article "evolutionarily stable equilibrium and Nash equilibrium", this paper introduces the concept of evolutionary stable strategy and its development, and introduced the evolutionary stable equilibrium, application and the application of minimal polynomial to it and the relationship between the Nash equilibrium. Feng Congwen (2001), in his essay "rationality and bounded rationality", is a clue to reason and finite reason, and mainly introduces the difference and relationship between evolutionary game theory and classic game theory. After pointing out the defects of classical game theory, the necessity and possibility of evolutionary game theory are given, and the definition of evolutionary stability strategy is given, and the two theories are compared. Xie Shiyu(2001) in his article "evolutionary game theory under the condition of limited rationality", discusses the effect of limited rational based on game theory, this paper introduces the thought and analysis framework of evolutionary game theory and evolutionary game theory and application value.

Tang Dexiang and other scholars analyze the application and emergence of evolutionary game theory from the perspective of stock investment. Tang Dexiang (2003) in his article "the evolutionary game theory to our country stock market investor types of deep dynamic equilibrium dialysis", the analysis at present our country stock market investors are irrational investors # of the evolutionary game theory "bounded rationality" than the traditional financial theory and the mainstream theory of "completely rational" hypothesis conforms to the reality in our country stock market investment decision-making behavior. Wang Bin (2007) in his article "the development of evolutionary game theory analysis of China's financial industry", the use of evolutionary game theory in the financial sector, and has set up a general model to explain the path dependence in the process of the financial system change, discovered that all of the financial system is an optimal pareto efficiency. Ma Weifeng (2007) in his article "China financial fragility paradox: an evolutionary game theory explanation". This paper presents a game theory analysis framework and USES evolutionary game model to explain the paradox of financial fragility. The research shows that the paradox exists because the Chinese financial system, especially the banking system, implicitly guarantees the government's credibility. Li Cheng (2009) in his article "based on evolutionary game theory to the understanding of the our country financial supervision coordination mechanism", the application of evolutionary game theory perspective of the people's bank of China and the three financial regulatory supervision coordination behavior, as well as to our country financial regulation coordination efficiency test. It is found that the initial state of the income of the financial regulation cooperation determines the strategic choice of the supervising subject to a certain extent. Ouyang Hui (2014) in his article "the financial innovation and financial regulation in China based on evolutionary game problem research", the study on the relationship between the both based on evolutionary game theory analysis, think that should change high cost and low efficiency of traditional regulatory mode, encourage financial innovation, and improve financial institutions innovation enthusiasm.
METHODOLOGY AND DATA

Methodology

Evolutionary stable strategy is proposed in the study of ecological phenomena, the behavior of each species in the ecology can be stylized as a strategy, so all the population in an ecological environment can be seen as a big group, and between individuals in the group is symmetric game, therefore the original evolutionary stable strategy definition applies only to symmetric game. This paper introduces the definition of evolutionary stability strategy using symmetric game. Suppose that there is an individual number \( n \) \((N= \{1, 2\ldots n\})\) is a large group, where \( n \) is a sufficiently large number. Each individual in the group has the same pure policy set, so the mixed strategy set \( S \) can be defined as:

Formula 1:

\[
S := \{ x = (x_1, x_2, \ldots, x_K): x_i \geq 0, \sum_{i=1}^{K} x_i = 1 \}
\]

In this paper, the individual investor's investment strategy and its influencing factors are combined to redefine the variables in the equation. \( y_i \) represents the individual stock investment returns, \( x_1, x_2, \ldots, x_n \) represents exposure to education, risk attitude, gender, occupation, etc., which may affect the expected return of stock. \( \beta_0 \) is the intercept coefficient \( \beta_1, \beta_2, \ldots, \beta_n \) is the slope coefficient. \( \mu \) stands for residual. The study of this paper will revolve around equation 1.

Equation 1:

\[
y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n + \mu
\]

Data

The study used data from the China family finance survey (CHFS) from the southwestern university of finance and economics. Chinese family financial investigation (CHFS) was sponsored by the southwest university of finance and economics for Chinese family financial investment and earnings, covers most of the Chinese mainland provinces, nationally representative data of the sample. The data is made up of two parts: one is personal information data, including information about age, gender, nationality, etc. The other part is family information data, including the family investment decision makers, family investment range of products information such as the time limit, the income of investment, better data requirements covered in this paper. In this paper, the two databases of CHFS are related to data, such as family stock investment income and personal exposure to education. Specific data collation and data analysis process are realized through Stata software.

RESULTS

Combining equation 1, the method of OLS regression analysis was used. Analyze the data in CHFS. We can get the regression results shown in table 1.
TABLE 1. REGRESSION RESULTS OF OLS.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) profit</th>
<th>(2) rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>edu</td>
<td>0.0140</td>
<td>0.0430*</td>
</tr>
<tr>
<td></td>
<td>(0.0139)</td>
<td>(0.0235)</td>
</tr>
<tr>
<td>male</td>
<td>-0.0240</td>
<td>0.0679</td>
</tr>
<tr>
<td></td>
<td>(0.0510)</td>
<td>(0.0862)</td>
</tr>
<tr>
<td>risk</td>
<td>0.100***</td>
<td>-0.0135</td>
</tr>
<tr>
<td></td>
<td>(0.0194)</td>
<td>(0.0342)</td>
</tr>
<tr>
<td>number</td>
<td>0.000444</td>
<td>-7.37e-05</td>
</tr>
<tr>
<td></td>
<td>(0.000574)</td>
<td>(0.000907)</td>
</tr>
<tr>
<td>occup</td>
<td>0.271*</td>
<td>0.103</td>
</tr>
<tr>
<td></td>
<td>(0.154)</td>
<td>(0.259)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.511***</td>
<td>-0.339</td>
</tr>
<tr>
<td></td>
<td>(0.325)</td>
<td>(0.548)</td>
</tr>
<tr>
<td>Observations</td>
<td>979</td>
<td>853</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.031</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As shown in table 1, the first line represents the dependent variable in the regression analysis. This paper analyzes the profit and yield of the stock investment respectively. In the analysis, Profit is used as a binary variable. Profit is zero on behalf of individual investors, and Profit is Profit for individual investors. The Rate represents the profit and interest Rate of individual investors, expressed as a percentage. The first column in the table represents the analysis of the independent variable, respectively is personal (edu) by the education level, gender (male), risk attitude (risk), individual investors hold stock quantity (number) and individual investors in the securities company (occup). Male, risk and occup are binary variables. Male is equal to 1 for Male, Risk is equal to 1 for Risk preference, occup equals 1 for securities company. The second column of the table represents the regression results of profit, which can see the impact of each independent variable on the profitability of individual investment stocks. Specifically, edu coefficient of 0.014 is a positive Number, the Male of the coefficient is 0.024, the risk coefficient is 0.1 and is very significant, the Number of coefficient of 0.0004 is a small positive Number, relatively great Occup coefficient is 0.271. The third column represents the regression result of rate, and the coefficient of Edu is 0.043, and the coefficient of Male is 0.0679. The coefficient of Risk is a negative number, negative 0.0135, and the coefficient of number is a negative number, and it is very small. The coefficient of Occup is a positive number, which is 0.103.

Compare the regression results of the second and third columns in the previous table. We can find that education, gender, the degree of risk appetite, hold shares, and whether in the securities company, for individual investors stock investments will be profitable and profitability for many of these two factors is not the same, or even opposite in some ways. The performance is as follows:

First of all, from the point of education degree factor, for investors to take profits and raise the level of yield has positive effect, but in comparison, the education degree
of the impact on the stock investment rate is bigger, and more significant. Second, gender has a very different impact on how much equity investment can be made and how much the interest rate is. From the results of regression analysis. Men have higher expected return on equity investment than women, but women are more likely than men to get stock gains. This view differs from the existing literature. Once again, risk appetite has the opposite effect on whether equity investments can be profitable and yield. From the results of the regression coefficient, people with high risk appetite are more likely to be profitable. But its return on equity yields will be lower. This suggests that investors in risk appetite are indeed more likely to be successful in their investments, but at the same time the expected loss of their investment losses will be greater. Once again, the number of shares held has little impact on whether investors will be able to make a profit and the expected rate of return. The portfolio theory is not proven here. Finally, the role of investors in securities companies has a positive impact on whether they can get stock investment profits and yield. The effect on profitability is greater and more significant, and the impact on profitability is relatively small.

CONCLUSIONS AND FUTURE RESEARCH

In combination with the above analysis, this paper considers that, as individual investors of retail investors, it is more concerned with the question of whether profits and profit margins can be obtained in the stock market. Therefore, we suggest that families participating in the equity investment can do the following considerations when investing in stocks.

First of all, if family expect stable profit instead of the expected rate of return the maximum value of how much, so the optimal decision is the decision of the investment of the family to a high degree of risk appetite, and family members in the securities industry experience. These people tend to earn more stable returns on their investments in securities.

Second, if the family to participate in the stock market investment is not in order to get stable profit, but hope to get higher yields in a transaction, then can try to have a family in the securities industry working experience of male members to make a decision. These people tend to have higher expected return on stock investment.

Finally, if the family is involved in the stock market investment, it is hoped that the stability and profitability of the return will be maximized. It should make decisions for people with a higher level of education in the family. These family members perform better when dealing with the relationship between income and stability, whether or not they have the experience of working at a securities firm.

This paper divides the income of individual investors into two parts from the perspective of investment income stability and yield. The data are analyzed and the corresponding results are obtained. However, the Chinese household financial survey data used in this paper belongs to section data and the variables are relatively limited. On the basis of the updated data, this paper will use the method of dynamic analysis to describe the returns of investors, so as to obtain more realistic analysis results.

REFERENCES

3. Xie Shiyu. Evolutionary game theory under limited rational conditions, Journal of Shanghai university of finance and economics, 2001(10)