Data mining in psychological experiments: a research of the relationship between personality, resilience and investment behavior rigidity

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Abstract. Data mining in psychological experiments is to discover the relationship between other data and psychological data, so as to discover the psychological state of the subjects. Based on the psychological assessment data of students from Jiangsu Vocational College of Agriculture and Forestry during 2017-2019, we applied the association rules in big data processing to calculate the scores of personality, resilience and rigidity of investment behavior of the subjects. The following conclusions are drawn through analysis of promotion degree and correlation degree between values of each attribute. Firstly, pruning lift is of great significance to understand the associated relationship among personality, resilience and investment behavior rigidity. Secondly, the more openness individuals in the Big Five personality, the stronger the investment behavior rigidity. The stronger the neuroticism, the weaker the investment behavior rigidity. The stronger the extroversion, the stronger the investment behavior rigidity. Thirdly, psychological resilience as a mediator affects the impact of openness and neuroticism on the rigidity of investment behavior.

1. Introduction

Data mining in psychological experimental is to discover the relationship between other data and psychological data, so as to discover the psychological state of the subjects. Some scholars applied the association rules of big data processing method to the data processing of psychological assessment, and made valuable exploration [1].

Researchers generally believe that personality traits are importantly related to investment behavior [2-3]. In the literature on the study of personality traits, the most dominant model is the Big Five personality [4]. The Big Five personality model divides personality into five overall dimensions, each of which consists of six levels. Investment behavior rigidity is a behavioral indicator that measures to what extent that investors maintain their investment strategies. It refers to the stability and unchangeable characteristics of the investment behavior in the investment process due to factors such as negative information. In an uncertain situation, the market is full of information with unknown authenticity. Investors can neither obtain complete information related to decision-making, nor can they accurately judge the authenticity of information and the results of decision-making schemes. They can only rely on limited information, according to the logic of process rationality to make decisions. Investors with stronger investment behavior rigidity will maintain more original investment portfolios in investment decisions, while investors with weaker investment behavior rigidity will change more frequently. However, some scholars believe that psychological resilience has an important impact on investment behavior and may affect the relationship between personality and investment behavior, but experimental research on this aspect is lacking.

Based on the psychological assessment data of students from Jiangsu Vocational College of Agriculture and Forestry during 2017-2019, we applied the association rules in big data processing to calculate the scores of personality, resilience and rigidity of investment behavior of the subjects. We measure the responses of different personality types of investors in the context of continuous investment decision-making through behavioral experiments, and analyze the internal relationship of personality, investment behavior rigidity and resilience.
2. Literature Review and Hypotheses

2.1. The Big Five personality
Researchers conducted a lot of studies about the relationship between the Big Five personality and investment behavior. Durand [5] classified investors into different personality types. They pointed out that the stocks of the investments should be consistent with the personality types in order to generate more returns. Evans [6] found that individuals with lower applicability, higher intelligence scores, and lower rigor scores accommodate more losses in financial investments. Oehler [7] used a day's trading data of 80 anonymous traders to find that investors' trading performance was negatively correlated with amenity, neuroticism, responsibility and openness, and positively correlated with extroversion. Mayfield [8] analyzed the data of the traders and traders of the four investment banks and found that the trades performed well and were stable and introverted traders and they were highly correlated with extroversion. Akhtar [9] found that the exogenous, openness, and conscientiously high scores of investing individuals have higher returns, while those with high neuroticism and amenity scores have lower financial returns. Wang [10] conducted a questionnaire survey of 1063 investors in seven cities in China, and found that investors have higher knowledge of investment objects, more investment knowledge, and greater possibility of investors’ independence and self-efficacy. Equity investors with high extroversion can concentrate their energies and make decisive decisions during investment. They can also eliminate the interference of negative emotions, reasonably analyze and grasp market opportunities and choose rational behaviors. Trading venues are good at getting people to get more information about stock investment decisions. When stocks fall, extroverted individuals may be more rational and decisive, and less affected by sunk cost. Individuals with high appetite are sometimes too skeptical of others' evaluations, and are more susceptible to negative information in the market. It is difficult to adhere to their own ideas in investment decisions. Investors with high agreeableness scores are easy to follow the reaction of most investors in the market. When they see other people buying or selling, they often follow the buying and selling decisions. Individuals with high conscientiousness scores tend to have strong self-discipline, restrain greed when stocks rise, and throw stocks when they fall. Individuals with high neuroticism scores are mainly emotional when operating stocks and are susceptible to incidents. When stock prices change, they often produce extreme emotions and lose their rationality. Investors with high openness are more adventurous, and in the uncertain situation, extroverted investors may have stronger investment behavior rigidity. In addition, the more openness investors are better at getting more information and being able to cope with the complex and volatile stock market.

2.2. Investment behavior rigidity
Investment behavior rigidity refers to the stability and unchangeable characteristics of the investment behavior of the individual in the investment process due to factors such as falling asset prices and negative information. It reflects the persistence behavior of investors in the investment decision in the face of unfavorable information and setbacks. In an uncertain situation, the market is full of information with unknown authenticity. Investors cannot obtain complete information related to decision-making, nor can they accurately judge the authenticity of information and the results of decision-making. They can only rely on limited information, and make decisions according to the logic of process rationality. Investors with stronger investment behavior rigidity will maintain their original investment portfolio more in their investment decisions, while investors with weaker investment behavior rigidity will change more frequently.

Investment behavior rigidity is a behavioral indicator that measures the extent to which investors maintain their investment objectives and strategies in the investment process. When an investor makes an investment decision, due to changes in the market, the surrounding and other constitutional factors, investors will more or less adjust the investment strategy and even the investment target. For some investors, small changes in decision-making situations will cause them to quickly adjust existing decisions, while for others, they may wait and see, and adjust when the situation changes more. Some even realize that the situation has changed, but it will not be adjusted until the investment is over. Therefore, the following assumptions are made:

Hypothesis 1: Investors with higher extroversion personality scores have stronger investment behavior rigidity
Hypothesis 2: Investors with higher agreeableness scores have weaker investment behavior rigidity
Hypothesis 3: Investors with higher conscientiousness scores have weaker investment behavior rigidity
Hypothesis 4: Investors with higher openness score have stronger investment behavior rigidity
Hypothesis 5: Investors with higher neuroticism scores have weaker investment behavior rigidity

2.3. Resilience
Resilience is a good adaptation of individuals to adversity and stress. It means that the "rebound ability" of life stress and frustration has been a hot topic in positive psychology research in recent years. There are three definitions of psychological resilience in the academic world, namely, procedural definition, result definition and...
quality definition. The procedural definition regards psychological resilience as a dynamic process of development and change, focusing on the process of individuals recovering quickly and successfully responding to major stresses and dangers. The definition of the definition defines the psychological resilience from the development results. It is considered that the psychological resilience is a phenomenon in which the individual's adaptation to the environment and life is still good when the individual is seriously threatened. The definition of quality refers to mental resilience as an individual's ability or quality, which can help individuals to emerge from threats and difficulties. For the composition of psychological resilience, the existing research has not reached an agreement. Borgen and Amundson divided them into three dimensions: personal ability, self-esteem, and interpersonal control. Xing and Sun [11] divided it into self-efficacy, persistence, internal control, and family response. And five dimensions of social networks, Sollie and Kop divided it into five dimensions: goal concentration, emotion control, positive cognition, family support and interpersonal assistance. There are three reasons for the difference in psychological resilience. First, because of the different definitions of psychological resilience, researchers have different internal dimensions of psychological resilience. Second, research by researchers based on different contexts and tasks leads to different understandings of mental resilience. In investment decisions, psychological resilience is reflected in investors' insistence on investment objectives, the control of negative emotions caused by unfavorable situations, and investors' positive perceptions of investment scenarios. We divide the psychological resilience in the investment process into three dimensions: target concentration, emotion control, and positive cognition. In investment decisions, individuals with stronger mental resilience will be more focused on the target, and will not give up easily. The feedback from the outside world can not only properly control the emotions, but also relatively positively interpret the negative information. In addition, outside support also helps such individuals to emerge from the shadow of failure decisions. Therefore, we propose hypothesis 6.

Hypothesis 6: Mental resilience is positively correlated with decision-making rigid behavior, and the stronger the psychological resilience, the higher the rigid behavior coefficient of individuals.

Psychological resilience is closely related to positive personality and personality traits. Studies have found that subjects with higher psychological resilience will show higher due diligence, amenity and openness, and lower neuroticism. Neuroticism is inversely related to psychological elasticity, and high neurotic individuals have poor elasticity recovery; and neurotic negative predicts psychological elasticity. In the study of decision-making behavior, neurotic energy influences investment decision-making behavior through the intermediary role of psychological flexibility. Studies have shown that neuroticism has a negative impact on the generation and development of psychological resilience, which is not conducive to individuals successfully coping with difficulties or frustrations, so neuroticism is a risk factor affecting psychological resilience. Based on this, we propose hypothesis 7.

Hypothesis 7: Mental resilience as a mediator affects the role of neuroticism in investment behavior rigidity.

Based on theoretical assumptions, we construct the research model of this chapter (Figure 1).

3. Methods

3.1. Subjects
The survey was conducted at Jiangsu Vocational College of Agriculture and Forestry. The subjects are 134 students who had finished two courses of “Secondary Investment Theory and Practice” and “Personal Finance” in the past. They came from 21 different majors and had already learned the basic investment knowledge and can understand the basic operations of the investment.

![Figure 1. Conceptual model of personality, resilience and investment behavior rigidity](image)

The study was conducted in a random manner. It was divided into two sessions, each of which was divided into two stages. In the first stage, the participants were asked to fill out the Big Five Personality Questionnaire using a computer. After a rest of ten minutes, they take part in the second stage of the experiment under the guiding of the staff to measure investment behavior rigidity. The two stages required the participants to fill in the basic information. In the later statistics, the two-stage data could be combined and analyzed.
In order to obtain effective data and achieve the purpose of practical and effective research results, the screening criteria are set for the data: (1) the questionnaire with obvious answering rules in the questionnaire answer is deleted. (2) If there is a missing item, delete the questionnaire. (3) In the personality questionnaire, the problem of lie detection was set up. Two questions were asked before and after the question of “Always forget to put things back in the right place” and “Learn time and energy spent learning”, if the questionnaire option if the absolute value of the difference is greater than 2, the questionnaire is excluded. (4) In order to eliminate the influence of psychological valence on the rigidity of investment behavior, the measurement objects are screened, and the age of the subjects to be analyzed is similar to that of ordinary working-class families. The annual household income is about 10-25 thousand yuan. The monthly living expenses are around 800-1800 yuan. A total of 102 data were finally entered into the analysis.

3.2. Measurements
The measurement of this study involves multiple variables, first of all for the measurement of personality. Most of the existing researches on investment decision-making behavior use the small scale personality measurement questionnaire. Some researchers use 50 questions, and some use 20 questions. Although these scales help the questionnaire to be recycled, the quality of the questions is guaranteed, but the measurement of personality is not perfect. This study used the Big Five Personality Scale revised by Yangzhou University in 2016. The scale was based on the Big Five personality of the International Personality Item Pool and was refined. We used AMOS 20.0 verification validity to remove some items that did not meet the criteria (factor load less than 0.45), and finally included 24 items for extroversion; 24 items for amenity; 24 items for conscientiousness; 24 items for neuroticism Openness includes 24 projects, all of which are scored using a 5-level Likert scale. For the measurement scale of psychological resilience, the more mature ones are the scales compiled by Xing and Sun (2013), Sollie and Kop (2017). In order to respond to investment decision scenarios, we have considered existing scales and built investments around goal focus, emotional control, and positive perception. The psychological resilience scale of decision making.

In order to measure subjects' investment behavior rigidity, we developed an investment decision experiment, which is based on the cards. Subjects are required to perform the guiding operation during the measurement. The measuring tools include: 13 chips (10 chips are priced at 100 yuan, 2 chips are priced at 500 yuan, and 1 chip is priced at 1,000 yuan), which is used to indicate changes in the measured earnings; 20 dedicated measuring cards, each card The back is exactly the same, and the front shows different income changes. Among them, 2 shows a gain of 500 yuan, and 1 shows a gain of 1000 yuan. In addition, there are 17 blanks, indicating a return of 0. Paper and pen are used to record measurement data. The specific measurement process can be expressed in two aspects. (1) The measured object understands the measurement instructions under the guidance of the surveying personnel. The object to be tested needs to be clear of two points of information. First, measurement can help them better understand their investment behavior characteristics, so operating according to their own real ideas will lead to more accurate investment advice. Second, each time a participant draws a card, he needs to pay 100 yuan. There are three kinds of income for each card, which are 0, 500 and 1000, but the probability is unknown. Third, during the evaluation process, the higher the total return obtained by the participants, the better. (2) Start the first experiment. First, the surveyor randomly shuffled 20 cards and placed them on the back with the back facing up. Secondly, the surveyor puts 10 chips with a price of 100 yuan in front of the object to be tested, and informs the object to be tested again: the card can be randomly selected to see if it is a revenue card; each card needs to pay 100 yuan to the surveyor; Obtain a beneficiary card and choose whether to proceed. If the choice is yes, the proceeds marked on the card are invalid, and the object to be tested continues to experiment. If no, the measurement personnel pays the proceeds, and the experiment ends. The first one is opened by the experimenter by default and the receiver is charged 100 yuan. The surveyor records two data: the number of 100-dollar chips saved by the surveyor after the end of the experiment, and the sum S of the final gains of the measured object.

4. Results

4.1. Personality and investment behavior rigidity
We performed an independent sample T test on the ibr score. We grouped the samples according to the extrovert personality type index and its six dimensions, the first group being the low level group and the fourth group being the low level group. In the high-level group, compare the mean values between the groups, and the results are shown in Table 1.

The independent sample T test results showed that there were significant differences in ibr scores for different groups of extroversion levels. The mean value of the low-level group of extroversion was 4.84, and the average of the high-level group was 6.77. There were also significant differences in the ibr score between the two groups of
extroversion. The significance levels were 0.05 and 0.01, respectively. This shows that the higher the level of extroversion, the stronger the investment rigid behavior. hypothesis 1 is verified.

The independent sample T test showed that there was no significant difference in the ibr score between the different groups of the level of agreeableness. From the data results, there is no significant correlation between agreeableness and investment behavioral rigidity. hypothesis 2 is not verified. The independent sample T test results showed that there were no significant differences in ibr scores for different groups of due diligence levels. hypothesis 3 is not verified.

The independent sample T test results showed that there were significant differences in the ibr score at the 0.01 level for the different groups of openness levels. The mean for the low level group was 4.04 and the mean for the high level group was 6.77. It indicates that individuals with higher risk are more risk-seeking tendencies in continuous investment decisions. In the investment setbacks, more opportunities are often seen, so it is more willing to risk the original investment and the more rigid the investment behavior. Based on the comprehensive correlation analysis and the independent sample T test results, the openness trait is significantly correlated with the investment behavioral rigidity, and hypothesis 4 is verified.

The independent sample T test results showed that the ibr scores were significantly different at different levels of 0.01 in the different groups of neuroticism. The mean of the low-level group was 7.44, and the mean of the high-level group was 4.52. Based on the comprehensive correlation analysis and the independent sample T test results, the neurotic traits were significantly correlated with the investment behavioral rigidity, hypothesis 5 was verified.

Table 1. Independent sample T-test of personality

| Personality Trait       | IBR   | SD    | T      | Sig    |
|-------------------------|-------|-------|--------|--------|
| Extroversion (low)      | 4.84  | 2.794 | -2.784**| 0.008  |
| Extroversion (high)     | 6.77  | 2.122 |        |        |
| Agreeableness (low)     | 4.84  | 2.609 | -1.728 | 0.090  |
| Agreeableness (high)    | 6.00  | 2.173 |        |        |
| Conscientious (low)     | 5.20  | 2.291 | -1.845 | 0.071  |
| Conscientious (high)    | 6.42  | 2.436 |        |        |
| Openness (low)          | 4.04  | 2.557 | -4.079**| 0.000  |
| Openness (high)         | 6.77  | 2.215 |        |        |
| Neuroticism (low)       | 7.44  | 2.123 | 4.594**| 0.000  |
| Neuroticism (high)      | 4.52  | 2.365 |        |        |

Table 2. Regression analysis of IBR I

| Investment Behavior Rigidity | Model 1 | Model 2 |      |      |
|-----------------------------|---------|---------|------|------|
| Constant                    | 4.350   | 2.630   | 3.602 | 0.951 |
| Age                         | -0.037  | -0.274  | -0.011| -0.094|
| Aex                         | 0.912   | 1.738   | 0.948*| 2.064 |
| Race                        | 0.152   | 0.315   | 0.000 | 0.001 |
| Education                   | 0.431   | 1.360   | 0.118 | 0.411 |
| Communist                   | 0.850   | 1.121   | 0.699 | 1.050 |
| Cadre                       | 0.488   | 0.708   | -0.106| -0.171|
| Student Loans               | 1.559*  | 2.439   | 1.619**| 2.828 |
| Part-time work              | 0.333   | 0.649   | 0.378 | 0.836 |
| Experience                  | -0.036  | -0.072  | -0.279| -0.625|
| grade                       | -0.155  | -0.419  | -0.156| -0.485|
| Home income                 | -0.126  | -0.376  | -0.070| -0.236|
| Extroversion                | -0.003  | -0.137  |      |      |
| Agreeableness               | 0.014   | 0.466   |      |      |
| Conscientiousness           | -0.027  | -0.932  |      |      |
| Openness                    | 0.082** | 3.282   |      |      |
| Neuroticism                 | -0.058**| -3.117  |      |      |
| F                           | 1.446   | 3.442   |      |      |
| R2                          | 0.150   | 0.393   |      |      |
| Adj.R2                      | 0.046   | 0.279   |      |      |
4.2. Resilience personality and investment behavior rigidity

First, we use conscientiousness, extroversion, agreeableness, openness and neuroticism as independent variables, and investment behavior rigidity as a dependent variable, adding control variables, and performing hierarchical regression. The regression results are shown in Table 2. In the regression analysis, the coefficient of openness and neuroticism and investment behavioral rigidity is significant at the 0.01 level, which indicates that openness and neuroticism have significant effects on investment rigid behavior. According to the recommendation of Wen Zhonglin et al., we are in the second step of analysis. Excluding the variables such as conscientiousness, extroversion and agreeableness that are not significant, with openness and neuroticism as independent variables, psychological resilience as dependent variable, and adding control variables such as gender, age and family income status to carry out hierarchical regression. The regression results are shown in Table 2.

The results show that the influence of openness and neuroticism on psychological resilience is significant. Among them, openness has a positive impact on psychological resilience, and neuroticism has a negative impact on psychological resilience. Individuals with more openness are more sensible in facing setbacks or losses, able to vent negative emotions in time, and then actively face life and work, which means that open-ended investors are more likely to emerge from the shadow of setbacks and losses. Mental resilience is stronger than the average investor. Individuals with high levels of neuroticism often show more negative psychological states in the face of setbacks or losses. They will have different levels of anxiety and depression, and will have impulsive behavior in later life and work, which makes them more difficult to get out of the shadow of failure. According to the procedure of mediating role test, openness, neuroticism and psychological resilience are used as independent variables, and investment behavior rigidity is used as the dependent variable, and the control variables such as gender, age and family income status are added to carry out hierarchical regression. The regression results are shown in Table 3.

The results showed that the influence coefficient of openness and neuroticism on psychological resilience was significant at 0.05 level, and the influence coefficient of psychological resilience on investment behavioral rigidity was significant at 0.05 level, and the direction of influence was positive. Individuals with stronger psychological resilience are more likely to face failures and setbacks, and are more likely to emerge from the negative effects of defeat. Failures and setbacks in the investment process are inevitable. Investors with stronger psychological resilience tend to have stronger risk tolerance. Short-term losses will not fundamentally affect their investment direction and plans. Therefore, the more rigid their investment behavior, the hypothesis 2 is verified.

Comparing Tables 2, 3 and 4, after adding the variable of mental resilience, the fitting index of the regression model is increased from 0.296 to 0.358, and the explanatory ability is improved, while the two variables of openness and neuroticism are rigid for investment behavior. The significance of the regression coefficient is reduced, which indicates that psychological resilience plays a partial intermediary role in the influence of openness and neuroticism on the rigidity of investment behavior.

| Table 3. Regression analysis of resilience |
|------------------------------------------|
| Resilience                              |
|                                          |
| Model 1                                  |
| β      t          | Model 2                                  |
| β      t          |
| Constant 3.332** 6.980                     |
| Age  -0.027 -0.707                           |
| Aex   0.093 0.617                             |
| Race  0.043 0.308                             |
| Education 0.132 1.447                       |
| Communist 0.074 0.339                      |
| Cadre 0.225 1.134                           |
| Student Loans 0.061 0.332                  |
| Part-time work 0.000 -0.002                 |
| Experience -0.026 -0.178                    |
| grade 0.000 0.001                            |
| Home income -0.057 -0.587                   |
| Extroversion 0.003 0.405                    |
| Agreeableness -0.012 -1.408                 |
| Conscientiousness 0.009 1.054               |
| Openness 0.021** 2.941                      |
| Neuroticism -0.015** -2.839                 |
Table 3, cont

|        |       |       |
|--------|-------|-------|
| F      | 0.698 | 3.129 |
| R²     | 0.079 | 0.371 |
| Adj.R² | -0.034 | 0.252 |

Table 4. Regression analysis of IBR II

| Investment behavior rigidity | Model 1 | Model 2 |       |       |
|------------------------------|---------|---------|-------|-------|
|                              | β       | t       | β     | t     |
| Constant                     | 4.350   | 2.630   | 0.816 | 0.214 |
| Age                          | -0.037  | -0.274  | 0.010 | 0.088 |
| Aex                          | 0.912   | 1.738   | 0.851 | 1.908 |
| Race                         | 0.152   | 0.315   | -0.029| -0.070|
| Education                    | 0.431   | 1.360   | 0.075 | 0.268 |
| Communist                    | 0.850   | 1.121   | 0.691 | 1.074 |
| Cadre                        | 0.488   | 0.708   | -0.090| -0.150|
| Student Loans                | 1.559*  | 2.439   | 1.561**| 2.814|
| Part-time work               | 0.333   | 0.649   | 0.326 | 0.744 |
| Experience                   | -0.036  | -0.072  | -0.205| -0.474|
| grade                        | -0.155  | -0.419  | -0.161| -0.518|
| Home income                  | -0.126  | -0.376  | -0.063| -0.219|
| Extraversion                 |         |         | -0.006| -0.255|
| Agreeableness                |         |         | 0.026 | 0.868 |
| Conscientiousness            |         |         | -0.035| -1.252|
| Openness                     |         |         | 0.062*| 2.441 |
| Neuroticism                  |         |         | -0.043*| -2.313|
| Resilience                   |         |         | 0.967*| 2.600 |
| F                             | 1.446   | 3.856   |       |       |
| R²                            | 0.150   | 0.438   |       |       |
| Adj.R²                        | 0.393   | 0.325   |       |       |

5. Conclusions

In this paper, we developed a concept of investment behavior rigidity, and examined the relationship of investment behavior rigidity, the Big Five personality and resilience. First, the more openness individuals in the Big Five personality, the stronger the investment behavior rigidity. The stronger the neuroticism, the weaker the investment behavior rigidity. The stronger the extroversion, the stronger the investment behavior rigidity. Second, psychological resilience has a significant positive impact on the rigidity of investment behavior. Third, psychological resilience as a mediator affects the impact of openness and neuroticism on the rigidity of investment behavior.

In consideration of stock characteristics, individual investors can increase expected returns through investment behavior rigid measurement tools. Investors with strong investment behaviors can choose small-scale, high-growth technology stocks or stocks of small-scale, low-priced local traditional enterprises, choose long-term holdings and obtain sustained returns. Investors with weak investment behaviors can choose large-scale, high-growth theme stocks, while maintaining good liquidity of assets, while maintaining flexible strategic adjustments which can obtain higher expected returns.

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