

“Influence of Behavioral Biases on Cognitive Abilities”

¹Dr. Taqadus Bashir, ²Farzana Kausar, ³Mariam liaqat, ⁴Shabeela Sarwar,
⁵Zubia Arshad, ⁶Jahanzaib Rasool

¹(Assistant Professor, Department of Management Sciences, University of Gujrat, Pakistan)

^{2,3,4,5,6} (MS Scholar, Department of Management Sciences, University of Gujrat, Pakistan)

Abstract: The study aimed to analyze the role of individual's level of cognitive abilities in making financial decisions and whether these abilities are affected by their behavioral biases. Cognitive reflection test (Fredrick, 2005) was used to investigate that whether behavioral biases that play major role in financial decisions are related with cognitive abilities. The research found that individuals who scored high on CRT are less likely to overconfidence, conjunction fallacy and conservatism biases. The research also related CRT with subjects such as time preferences and risk preferences and found that high score group are more patient and more risk seeker in domain of gain and less risk seeker in domain of losses. However behavioral biases are lower for people having higher cognitive abilities but they are still present in financial decisions.

Key words: behavioral biases, cognitive abilities, cognitive reflection test, time preferences, risk preferences

I. Introduction

Traditional finance and economics suggests that only outcome matters there is strong believe that behavioral biases do not play major role in decision making because they are corrected by rational arbitrage, it assumes that investors are rational. However Barbies and Thaller (2003) contend that rational arbitrage cannot eliminate all effects of behavioral biases used by investors in their financial decision. Number of studies has been conducted about the relationship between cognitive abilities and economic behaviors of individuals.

Individuals with high cognitive abilities are different from people having low cognitive abilities Fredrick (2005). They live long, have long working experience and earn more than others (Jensen, 1998).

In economic models there are two fundamental determinants of decision making i.e. preferences and cognitive ability. Studies showed that economic outcomes are predicted by individuals risk aversion and impatience (Eckel et al., 2005), higher cognitive abilities results in better labor market outcomes (Heckman et al, 2006). Individuals having higher cognitive abilities are less likely to risk averse and are more patient than individuals having low cognitive abilities (Dohmen et al, 2007). In this paper we replicate earlier studies and their findings with two

Determinants time preferences and risk and also by extending the hypothesis with number of behavioral biases that plays major role in financial decisions (see Barbies and Thaller, 2003). In financial decisions individuals are prone to conjunction fallacy, overconfidence and conservatism etc.

In this paper we conduct a test for hypothesis that effects of behavioral biases are related to cognitive abilities. For this purpose we use cognitive reflection test (CRT) with two determinants risk and time preferences suggested by Fredrick (2005), it's a 3-item test which can be conducted within 5 minutes, is a very good predictor of cognitive abilities related with math abilities.

Cognitive reflection test (CRT):

Many researchers have contended that there are two types of cognitive processes. System 1, in which decisions are made quickly with little deliberation and conscious. System 2, in which decisions are slower and more reflective (Epstien 1994, Kahneman and Fredrick 2002). System 1 decisions are spontaneous and require little attention e.g. recognizing face of HOD entering in the office is the system 1 decision because it does not require attention and is not affected by intellect. Solving a math problem is system 2 decision which requires attention and intellectual process.

Cognitive reflection and time preferences:

It is contended that people with higher cognitive abilities are more patient (Dohmen et al, 2010) and less likely to discount their future rewards. This notion has not been systematically studied therefore to this end we examined the relationship between cognitive abilities and time preferences. Those scored higher on the CRT are more patient and less likely to discount rates.

Cognitive reflection and risk preferences:

Correlation between cognitive abilities and risk preferences exist for both males and females even after removing personal characteristics such as age gender etc. (Dohmen et al, 2010). To examine this relationship we use CRT in which several measure of risk preferences are included. In gain domains individuals who scored higher are more willing to gamble i.e. risk seekers but in Domain of losses these individuals are less risk seekers they opted for sure loss to avoid playing gamble with lower expected values (Fredrick, 2005).

II. Literature review

Cognitive abilities (mathematical, verbal fluency, and recall skills) are associated with stock holdings decisions. Cognitive impairments limit investor’s ability to gather and process information, hence acts as preventing barrier. Low cognitive abilities results in misperception of risk or higher risk aversion’ less patient and overconfidence behavior while high cognitive abilities results in less risk averse and more patient behavior (Christeliset all, 2007).

Cognitive abilities provide information about the characteristics of risk aversion and impatience so that individuals can properly understand design and screening strategies of contract. Individual with high cognitive abilities take more risks in lottery experiments and significantly more patient in long time horizons. The correlation between cognitive abilities and risk aversion exists for both males and females, young and old even after removing variation due to personal characteristics such as age, gender and other economic variables such as education and income level etc. patience and willingness to take risk tend to foster the accumulation of greater cognitive ability, interventions focused on influencing these noncognitive skills could provide a different approach to improving cognitive ability and economic outcomes(Dohmen et al, 2010).

Cognitive abilities play very important role in financial decision making. Individuals having higher cognitive abilities are more likely to participate in the stock market and earn more financial returns than the individuals with low cognitive abilities. He analyzed that age has significant effect on cognitive abilities. Both physical and cognitive abilities decline as age increases which results in weaken memory that lead towards slow information processing ability. Older people react to new information inappropriately because they are ineffective in information processing which results in ineffective investment decision. However decline is weaker for individual who are highly qualified, have more resources and intellectual job experience because they are able to compensate adverse effects of aging (Kumar, 2008).

People with higher cognitive abilities differ from those have low cognitive abilities (Jensen, 1998).

Frederick (2005) examined the relationship between cognitive abilities and decision making by using cognitive reflection test (CRT) with two important decision making characteristics i.e. time preference and risk preference. Individuals who scored higher on CRT were more patient and their decisions implied lower discount rates (time preference). High CRT individuals are risk seeker when they expect higher returns; on the other hand they are less risk seeker when items include losses (risk preference).

A study was conducted by Peracchi (2009) to discover the relation between aging, retirement and cognitive abilities. The results revealed that the retirement and education plays a key role in showing downwards in cognitive abilities. The study was conducted on 50 plus age individuals or investors. As the age increases the level of cognitive abilities tends to decline at a greater level. This level may be stable till the age of fifty afterwards its downfall starts (Schaie, 1989). Also two types of abilities which includes fluid intelligence and crystallized intelligence were differentiated in which fluid intelligence consist of basic intelligence whereas crystallized intelligence which is gained through studies and experiments it remains constant as the age increases while fluid intelligence declines with passage of time Salthouse (1985). And also the cognitive abilities lead towards decline after the age of retirement of individual.

Parker and Fischhoff (2005, p.16) found that “decision making performance was predictably related to measures of cognitive abilities”. Individuals with low cognitive abilities tend to affected more by behavioral biases such as base rate fallacy and overconfidence (hoppe&kusterer, 2011). However some biases cannot be related with cognitive abilities because highly intelligent individuals are less likely to show behavioral biases because when you tell them about the bias they victim of and what they need to do to avoid it (Stanovich& West 2008).

Agarwal and Mazumder (2013) analyzed the effects of cognitive abilities on two house hold financial decisions (i.e. credit card use and use of line of credit and home equity loan) which define suboptimal behavior in their debt management. Cognitive abilities such as ability to process information and financial calculations are very important in making optimal financial decision. Individuals with higher cognitive scores particularly with higher math scores are less likely to make financial mistakes in using credit card transfer offers and home equity loans or line of credit applications.

Boyle et al.(2011) found relationship between cognitive abilities and risk aversion in middle aged individuals. They suggested that cognitive abilities are negatively associated with risk aversion by using SAT (educational attainment test). Demographic factors (age, education and sex) and other contextual factors

(income etc.) also associate with risk aversion. Individuals with high cognitive abilities can easily process information therefore is less likely to risk averse. However individuals with lower cognitive abilities are more likely to invest conservatively (i.e. they invest their bulk of wealth in safe modes).

Tabea et al. (2011) conducted a study on at what level private households are affected by financial crisis and also how their investment decisions are affected by this crisis. By using Financial crisis as a experiment they came to know how whether and how these households are affected by this crisis. According to their findings households that have low literacy rate tends to invest very low in investing in stock markets and also reveals low losses while the households with high literacy rate tends to invest more and relatively predict high losses due to financial crises. The study also revealed that the less financially literate households leads towards selling their assets when facing financial crisis due to fear of bearing the loss. This may look worthy to them in the short run but in the long run it will not benefit them rather this financial literacy and illiteracy will leads to unfair incomes because the illiterate households miss the profits in the long run and also they will not make reinvestment in assets due to fear that will automatically leads towards inequalities.

Cole and Shastry(2009) designed a research on what are the effects of financial literacy and cognitive abilities on individuals for their participation in financial markets. They assumed that due to the participation securities prices and also the wellbeing of participants are affected but their knowledge on participation was limited. For this they conducted experiments that revealed that the education has a greater effect in participation and also the cognitive abilities pulls towards participation but financial literacy has no effect on this participation. Due to education people leads towards savings and that will leads to them in participating in financial markets, and this education will also affect the cognition abilities. On the other side the more people have financial education the greater they will participate in financial assets that will ultimately leads towards financial market participation.

Paluch(2011) found that cognitive abilities are affected with behavioral biases. Many tests have been done by researchers that correlate cognitive biases such as overconfidence, anchoring and base rate fallacy with cognitive abilities. Paluch found this correlation between different levels of management and suggest that managers with high cognitive reflection are more accurate and less overconfident in their managerial decisions.

However managers with low cognitive reflection tend to be both overconfident and unconfident. High intelligent people are less likely to behavioral biases.

Dimitris et al. (2009) conducted a study for checking the relationship between cognitive abilities and stock holdings. This study showed the results that the tendency of stock investing is associated at a higher level with cognitive abilities whether the individuals actively or inactively make participation in stock market, and also their study shows that this relationship is strongly attached at the availability of information. Several tracks were introduced due to which cognitive abilities may affect the decision process of whether to buy or not a stock or security one of which was cost of information. Information is easily less costly available to trained individuals whether it is not always easily available to less trained individual so this may become a hurdle in buying of stocks. Cognitive skills have also relations with individual preferences such as risk averter. So risk averse preference will also lead to omit the buying behavior towards a security, and also this study was conducted with aged individuals to check their preferences for stock purchasing and the results showed that low stock ownership relates to health position.

Seppala (2009) conducted a research on whether behavioral biases like hindsight, overconfidence and self-attribution possessed by investment advisors have any impact on client’s decision making who take the advices of these advisors. Because advices that possessed biases have impact on the decision process. Hindsight bias creates a hurdle of learning from past and makes the people not to learn from past that again leads them to provide wrong advices regarding investing. Also overconfidence and self-attribution leads to this type of behavior. The result indicates that advisors possess these three biases but hindsight is less than two other biases.

The results also have revealed that people who are intuition based are more prey to these biases and lead to pay less optimal advices to their clients who ultimately lead to poor performance and ending up the process of investing.

Taylor and Benbasat (1982) conducted study on behavioral aspects of information processing in designing management information system. They suggested that MIS can be improved by understanding cognitive abilities of individuals, cognitive complexity and individual differences in information processing.

Due to limited cognitive abilities in information processing, many behavioral biases such as representative, overconfidence, anchoring and availability distort human’s subjective judgment. Cognitive complexity can be reduced with capabilities and skills of people.

Experimental design:

120 subject participants were asked to fill the questionnaire cognitive reflection test. Subjects’ answers were related to several biases. Most of the participants told us about their behavioral biases while answering the

questions. Cognitive reflection test consists of three questions that made up the test other questions were asked to check the behavioral biases and consistency in the behaviors of participants.

Cognitive reflection test:

Cognitive reflection test was introduced by the Fredrick (2005). It is very simple test to judge the cognitive ability of the participants. It was to judge and answer the problem that whether a quick answer comes to the mind is correct or impulsive. Many participants answered impulsively to the questions but after having a deep insight of questions they concluded their answers wrong and tried to correct them while doing cognitive reflection test. Cognitive reflection test include three main questions

1. A bat and a ball together cost Rs. 110. The bat costs Rs. 100 more than the ball. How does the ball cost? (impulsive answer: Rs. 10 and correct answer: Rs. 5)
2. If it takes 5 machines to make 5 units, how long would it take 100 machines to make 100 units? (impulsive answer: 100 and correct answer: 5)
3. In a lake, there is a patch of lily bunch. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? (impulsive answer: 24 days and correct answer: 47 days)

III. Results

In cognitive reflection test subjects were asked three main questions and they were divided into two groups, High CRT group and low CRT group. Participant answered 2 or three correct answers were categorized in high CRT group and participant answered 0 or 1 answer correctly were in low CRT group. Subject in high CRT group were more reflection decision maker and participant in low CRT group were impulsive decision maker. High CRT group were less likely to show biases in their decision making because they take time ignore biases and then answered each question as compared to the low CRT group who were susceptible of many biases and answered impulsively without taking enough time to answer. We examined participant on risk, time and return and overconfidence preferences bases.

Risk preferences:

In case of bat and ball question 55 participants answered correctly and other 65 participant answered impulsively. 39% participant fall in the high CRT group and 47.1 participants were categorized in the low CRT group. in risk preferences they participant reflected risk averse behavior only 37.7% participant were risk seeker but remaining preferred return and reflected risk averse behavior, As they were asked to get sure payment and lottery with the 75% and 25% probability. Subjects choose sure payment in the domain of gain and lottery in the domain of losses when they have probability of 25% for having 0. In case of machine 28 participants were in low CRT group and answered impulsively and other 92 participants were in the high CRT group and they answered correctly. So the results showed that only 20.3% subjects were impulsive decision maker and the 66.7% were correct decision maker. After analysis due to many behavioral biases participants were unable to justify their risk preferences in this case they were acting as a risk averse person but due to many behavioral biases and risk preferences they answered 75% probability for payment of Rs.20 and 39.9% participant choose correct risk averse probability of payment in which they actually don't have to pay anything. In case of third question asked from participants 65 participant were impulsive decision maker which showed that 47.1% participants fall in the low CRT group and other 39.9% were categorized in the high CRT group.

Time preferences:

Analysis showed that 47.8% participants were concerned about time preferences and they demand earlier payment as a sure payment. But other 39.1% were return concerned participants. Those 47.8% avoided 10% premium because of risk adverse behavior and they demand payment immediately after the results. Latter were risk seekers but try to get more gain as in the form of 10% premium on the amount of winning. High CRT group was risk seeker group those demand payment after one month of results with 10% premium but low CRT group showed impatient behavior and try to avoid risk so they preferred short time of payment regardless of losing 10% premium on winning amount if they get payment after one month.

Behavioral biases and CRT score

| Category | Item | CRT Group | |
|---------------------------|---|-----------|------|
| | | Low | High |
| Risk | % preferred Rs. 10 for sure 75% chances of winning Rs.20 | 37.7 | 49.3 |
| | % preferred - Rs.10 for sure to 75% chance of losing - Rs.20 | 39.9 | 47.1 |
| Time | % preferred payment immediately Rather than 10% premium after 1 month | 47.8 | 39.1 |
| Confident | % low CRT group % high CRT group | 33.3 | 53.6 |
| Prediction overconfidence | % less overconfident % high overconfident group | 44.2 | 42.8 |

Overconfidence

In questionnaire participants were asked to answer about their questions whether they confident about their answers or not. Group of participants who answered 0 to 1 they were categorized in the low CRT group and just a little bit confident about their answers but other 53.6% subjects answered 2 to 3 and they fall in the high CRT group they were also susceptible of overconfidence bias. They overestimated their own ability due to several behavioral biases. They were susceptible of prediction overconfidence that they can predict and judge circumstances according to their beliefs. High CRT group were more confident about their answers. Low CRT group were less confident in their judgments and decision making.

Behavioral biases and cognitive ability:

CRT showed that participants are susceptible of many behavioral biases. They preferred return in the context of risk associated and change risk averse and seeker behavior with the time and return bases. Low CRT group of participant reflected low patience level and demand return immediately after the results of the research. Many participants when filling their questionnaire told about their behavioral biases that they are fallen prey to different biases but answering due to risk, time and return preferences. Some participants were more impulsive because they were conservative about their decisions. Subjects with availability bias answered last questions according to their own answers of the earlier question. They were showing resonance bias and consider if they have answered correctly every participant have answered same and those in low CRT group also reflected resonance bias because they consider questions very difficult and they consider everyone could not answered correctly.

Incentive and reward:

Incentive and reward mentioned on in the questionnaire were used as a tool to involve participants. When they were aware of the reward they try to correctly answer each question rather than impulsively in which behavioral biases of participants were reduced in some cases but it cannot be said that incentive can eliminate behavioral biases.

High involvement and low involvement group:

High involvement group indicated High CRT group and answered more questions correctly. They were less susceptible of behavioral biases and less risk averse. High CRT group was more patient about their payment and probability of payment. Low involvement group impulsively answered and try to get escaped from answers. They were less patient about their return and preferred less time and immediate payment of their winning.

IV. Conclusion

In test based experiment participant, the study was conducted to show the relationship between cognitive abilities and behavioral biases of participants. They were examined by a short test Cognitive Reflection Test introduced by Fredrick (2005). Participants were examined on many behavioral biases and at the most extent the test was successful in judgment of those impulsive and reflective decision makers. Participants were actually susceptible of many biases and during experiment they told us about their biases and decision based on several biases.

Experiment proved that biases more affect those people with low cognitive abilities. Participant with low cognitive abilities show impulsive decision making and reflected many biases. Participant with low CRT were more overconfident and less patient. They were more risk averse.

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Appendix:

Questionnaire

Name (optional) _____ Gender Male ___ Female ___
Occupation _____ Age 18-25 ___ 26-30 ___ 30 or above ___
Qualification Graduation ___ Masters ___ M.phil ___ P.hd ___
Marital status Married ___ Unmarried ___

We would be obliged if you could answer a few additional questions. The answers will take a few minutes only. Just imagine the following situation and then answer the questions:

In addition, you can win a prize of up to 1000 PKR: At the end of the experiment we will randomly draw 6 out of the 600 participants that will be paid for their answers in the following way. Please note that prizes will be positive. A winner will obtain:

- As a thank you for answering all of the questions a lump sum of 600 PKR.
- For questions 1, 4, 6, 8: 50 PKR for each correct answer.
- For questions 3 and 5: The amount in PKR that is realized in the respective lottery (we will actually carry out the lotteries).
- For question 7: 10 PKR minus an amount that is increasing in the deviation of your answer from the correct answer. Formally, we use the following formula: $10 - (\text{correct answer} - \text{your answer})$

Questions:

1. A bat and a ball together cost 110 PKR. The bat costs 100 PKR more than the ball. How much does the ball cost? [_____ PKR]
2. If you are one of the six winners who receive a prize for this questionnaire, you can pick between two alternatives.
Alternative 1: We will transfer your winnings immediately after the end of the experiment. Alternative 2: We will transfer your winnings one month after the end of the experiment with a 10% premium. Which alternative do you choose? [1/2]
3. You have the choice between two alternatives.
Alternative 1: You receive 10 PKR.
Alternative 2: You receive a lottery ticket that yields a 75% chance of winning 20 PKR. With 25% probability it is worthless. Which alternative do you choose? [1/2]
4. If it takes 5 machines 5 minutes to make 5 units, how long would it take 100 machines to make 100 units? [_____ minutes]
5. You have to pay 10 PKR. Would you rather replace this payment through the following alternative:
With a probability of 75% you must pay 20 PKR
With 25% probability you don’t have to pay anything. [yes/no]
6. In a lake, there is a patch of lily bunch. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? [_____ days]
You have just answered three questions about the prices of a bat and a ball (B),
About the production time of certain machines (M) and
About a patch of lily bunch (B).
In the following we shall refer to these three questions as “BMB—questions”
7. What do you think, how many of the BMB—questions did you answer correctly? [0,1,2,3]
8. Do you believe that more or less than 10% [60%] of all participants answered all three BMB—questions correctly? [less/more]