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# OCD and Errors in Financial Decisions

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## Abstract

Obsessive-Compulsive Disorder (OCD) is a disorder that entails repetitive thoughts (obsessions) and repetitive behaviors (compulsions) that are uncontrollable. It involves interruptions and impairments in cognitive functions and severe distresses. This paper finds the positive association between OCD and the probability of making judgment errors in financial decisions.

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# 1. Introduction

In a modern society that is fast-paced and competitive, people live under stress to achieve the better. In particular, striving to be too perfect may come with harmful side-effects such as repetitive thoughts (obsessions) and repetitive behaviors (compulsions) that are uncontrollable.[1] Specifically, Obsessive-Compulsive Disorder (OCD) is a disorder that entails obsessions and compulsions.[2] It involves checking certain things repeatedly, performing certain routines repeatedly, doing certain thoughts repeatedly.[3] The causes of OCD are not clearly known to date. Experiences of severe stress inducing events such as child abuses, genetic components, or even physical infections can bring OCD.[4] In other words, OCD can be caused by both of genetic and environmental factors.[5] Almost 2.3% of adults in the U.S. are affected over the course of a life.[6] There are vast studies supporting the negative effects of OCD on cognitive performance. OCD decreases proper valuation of behaviors and behavioral control, and increases excessive fears, negative stimuli, anxiety and distress.[7] Such worries are outside of the normal range of worries that average people experience.[8]

In the web-based choice experiment, the participants were presented with series of questions on risk and time preferences. Errors are identified in ways that are consistent with the distinction between irrationality and rationality in Rubinstein (1997). The measure of OCD is the 5-item Florida Obsessive-Compulsive Inventory (FOCI) Severity Scale (Storch *et al.* 2007).[9] The results show that errors increases in OCD. The probability of errors of OCD group is 13.2%, which is much higher than 5.9%, that of non-OCD group. The positive association is robust controlling demographic factors.

This paper can relate to the studies on non-traditional factors in financial decisions.[10] Section 2 presents the prediction, section 3 explains the data, section 4 shows the results, section 5 concludes.

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[1] Mallinger, DeWyze (1992), Egan, Wade, Shafran (2011), Antonyab et al. (1998), Frost, Steketee (1997)

[2] NIMH (2016)

[3] Examples include washing hands, cleaning, checking locking of a door, arranging things in certain ways, having certain distressing thoughts, etc.

[4] DSM-5 (2013)

[5] Since the causes of OCD can be both genetic and environmental, the goal of this paper is modest in that it examines the association between OCD and errors in financial decisions rather than testing a causal relation.

[6] National Comorbidity Survey, Harvard Medical School (2005)

[7] American Psychiatric Association (2013)

[8] American Psychiatric Association (2013)

[9] This self-administered measure is often used prior to clinicians' visits. Each question rates the severity of each of the OCD-related symptoms during the past 7 days. There are only a limited number of self-report measures which directly measure pediatric OCD. One of the well-known ones is the Yale–Brown Obsessive-Compulsive (Y-BOCS) Severity score introduced in Goodman *et al...* (1989). Another well-known measure is the recently developed FOCI Severity Scale. It is a very brief measure consisting of 5 items only, yet is highly correlated with strong correlation with Y-BOCS Total Severity score. (Storch *et al..* 2007, Aldea *et al..* 2009) Despite its recent development, this measure is widely used and features in various studies, i.e. Rapp *et al...* (2016), Foa *et al..* (2010), Grabill *et al..* (2008), as well as on the American Psychiatric Association website.

[10] For example, as to the effects of cognitive functioning on financial decisions, refer to Frederick (2005), Dohmen *et al..* (2010), Frydman, Barberis, Camerer, Bossaerts, and Rangel (2014), just to name a few. Also, as to soft factors, bargaining, moral hazard, commitment, implicit barriers, informal communication, just to name a few topics, refer to Xue, Diamantoudi, and Miyagawa (2015), Martinez, Jenkinson, Jones (2016), Errunza, Carrieri, Chaieb (2013), Errunza, Ta (2015), Martinez (2011), Banerji, Almazan, Motta (2008), Xue (2008), Banerji and Errunza (2005)

# 2. Prediction

Given the subjects' answers to risk and time preference questions, errors are identified as follow.[11]

A decision maker chooses one element from available alternatives in the set D.

[***Proposition 1***] If the decision maker has a preference relation $\succsim$ over all available elements in the set D, and chooses $y^*$ in D, where $y^* \succsim y$ for all $y \in$ D, that is $y^*$ is $\succsim$-optimal, then the decision is rational.[12]

In contrast, the irrational decision then should be a violation of proposition 1 or any of the related assumptions of it.

[***Proposition 2***] If the decision maker does not have a preference relation $\succsim$ over all available elements in D; or if the decision maker fails to choose $y^*$ in D, where $y^* \succsim y$ for all $y \in$ D regardless of having a complete or incomplete preference relation $\succsim$ over all available elements in D; then the choice is irrational.[13]

These irrational choices are referred to as 'Errors' for simplicity. Based on the proposition 2, errors are identified among the subjects' answers in the choice experiment. Specifically, any choice aligned with the following four types is identified as errors.

[***Type 1***] *With the probability of winning being constant, if a decision maker prefers a certain receipt of A over a risky B, and prefers a risky C over a certain A, then prefers a certain A over a risky D, where A<B<C<D, then the choice is an error.*

[***2***] *With the probability of winning being constant, if a decision maker prefers a certain receipt of A over a risky C, and prefers a risky B over a certain A, where A<B<C, then the choice is an error.*

[***3***] *With the time discount factor as well as associated time span remaining constant, if a decision maker prefers an immediate receipt of A over a later B, and prefers a later C over an immediate A, then prefers an immediate A over a later D, where A<B<C<D, then the choice is an error.*

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[11] Which is consistent with the distinction between irrationality and rationality in Ariel Rubinstein (1997): Refer to the footnote 14 for detailed explanation. Also, this measure of error is consistent with the economics' literature considering a violation of the transitivity axiom of the expected utility as being irrational. Refer to Tversky, Slovic, and Kahneman (1990), Loomes, Starmer, and Sugden (1991), Loomes and Taylor (1992), Holt and Laury (2002), Jacobson and Petrie (2009), for more evidence on inconsistent preferences and preference reversals.

[12] The rational decision involves certain assumptions. The decision maker understands the choice problem clearly and fully. The decision maker knows all alternatives. The decision maker has a complete preference ordering over all available alternatives. The decision maker has capabilities and skills needed for getting to the $\succsim$-optimal choice.

[13] Irrational choices can arise from any reason, i.e. violation of any of the related assumptions of proposition 1. For example, the decision maker might have insufficient knowledge of the choice problem or available alternatives, or have insufficient capabilities and skills necessary in finding the optimal choice, etc. In this paper irrational choices identified without being distinguished or differently treated in terms of the reasons.

[***4***] *With the time discount factor as well as associated time span remaining constant, if a decision maker prefers an immediate receipt of A over a later C, and prefers a later B over an immediate A, where A<B<C, then the choice is an error.*

The rationales of these errors are explained below.[14] The rationale of type 1 is as follow. If *B<C<D,* then *p(B)< p(C)< p(D)* since *p*, the probability of winning, is constant. Then *u(p(B))< u(p(C))< u( p(D)).* Equivalently, $B \prec C \prec D$ and $p(B) \prec p(C) \prec p(D)$. Therefore, the choice of type 1 violates the ordering of preferences as choices are inconsistent. For example, if one prefers a certain 100 over a risky 110, but prefers a risky 115 over a certain 100, but then prefers a certain 100 over a risky 120, then the choice is categorized as an error.

The rationale of type 2 is as follow. If *B<C,* then *p(B)< p(C)* since *p*, the probability of winning, is constant. Then *u(p(B))< u(p(C)).* Equivalently, $B \prec C$ and $p(B) \prec p(C)$. In other words, willingness to take risk should increase in the amount of associated risky payoffs. Thus, the type 2 choice, being more willing to take the risky receipt when the associated payoff is smaller is irrational. For example, if one prefers a certain 100 over a risky 120 but prefers a risky 110 over a certain 100, then the choice is categorized as an error.

The rationale of type 3 is as follow. If *B<C<D,* then *b(B)< b(C)< b(D)* since *b*, the time discount factor, is constant. Then *u(b(B))< u(b(C))< u( b(D)).* Equivalently, $B \prec C \prec D$ and $b(B) \prec b(C) \prec b(D)$. Therefore, the choice of type 3 violates the ordering of preferences as choices are inconsistent. For example, if one prefers an immediate receipt of 100 over a 110 in a year, and prefers a 115 in a year over an immediate 100, then prefers an immediate 100 over a 120 in a year, then the choice is categorized as an error.

The rationale of type 4 is as follow. If *B<C,* then *b(B)< b(C)* since *b*, the time discount factor, is constant. Then *u(b(B))< u(b(C)).* Equivalently, $B \prec C$ and $b(B) \prec b(C)$. In other words, willingness to wait should increase in the amount of associated later payoffs. Thus, the type 4 choice, being more willing to take the later receipt when the associated payoff is smaller is irrational. For example, if one prefers an immediate receipt of 100 over a 120 in a year but prefers a 110 in a year over an immediate receipt of 100, then the choice is categorized as an error.

The OCD prediction of errors is not structurally clear. However, according to the literature, the repetitive behaviors that come with OCD are time-consuming thus can interfere daily functioning, both social and scholastic.[15] OCD can lead to certain cognitive deficits, particularly regarding spatial and verbal memory, coding and processing of information, etc.[16] Thus, it is possible to predict that,

[***Prediction***] Due to the negative association of OCD with cognitive functioning, the probability of errors should increases in OCD.

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[14] All four types of errors do not involve any strategy of reasoning. That is, they cannot be explained by certain rational procedure of decision-making, that is, either of substantive rationality or procedural rationality. These are irrational choices, but neither boundedly rational nor rational choices. Refer to Simon Herbert (1957) and Rubinstein (1997) for differences between substantive rationality and procedural rationality, as well as between rationality, bounded rationality, and irrationality. For example, bounded rationality does not involve substantive rationality, but involves procedural rationality. (Rubinstein (1997)) In other words, bounded rationality involves some reasoning. In contrast, "irrational behaviour is an outcome of impulsive responses without adequate intervention of thought." (Rubinstein 1997)

[15] American Psychiatric Association (2013)

[16] Shin, Lee, Kim, Kwon (2013), Çetinay, Güleç (2013)

# 3. Experiment and Data

The data is collected from the web-based choice experiment conducted in South Korea, through the online panel survey service by DataSpring Korea Incorporated in winter 2016.[17] The participants were presented with questions in the Appendix 2. Demographic variables of age, gender, asset, earning, field of occupation, education are gathered.[18]

## 3.1. Measure of Errors

The participants were presented with series of questions on risk and time preferences.[19] The procedure of constructing variables of errors is as follow.

Error_risk is constructed as follow. Subjects are asked a series of questions in which they get to choose between a certain receipt versus a risky receipt given a constant probability of winning. The probability of winning can be 5%, 50%, or 95%. Any choice consistent with Type 1or Type 2 of errors in Section 2 is identified as an error. That is, if an error is observed in the answers to a series of questions asking to choose between a certain receipt versus a risky receipt given a constant probability of winning, say 5%, then Error_5 is recorded 1 and 0 otherwise. Similarly, Error_50 and Error_95 are created. Then Error_risk = (Error_5 + Error_50 + Error_95)/3. This is to make one variable of error in choices involving risk while reflecting various probabilities of winning.

Error_time is constructed as follow. Subjects are asked a series of questions in which they get to choose between an immediate receipt versus a receipt later in a certain time. The time span can be a week, a month, or a year. Any choice consistent with any of Type 3 or Type 4 of errors in Section 2 is identified as an error. That is, if an error is observed in the answers to a series of questions asking to choose between an immediate receipt versus a later receipt in a week, then Error_w is recorded 1 and 0 otherwise. Similarly, Error_m and Error_y are created. Then Error_time = (Error_w + Error_m + Error_y)/3. This is to make one variable of error in choices involving time trade-offs while reflecting various time spans.

Finally, ERROR = (ERROR_risk + ERROR_time)/2. This variable can be interpreted as the probability of error, reflecting decisions involving risk as well as decisions involving time trade-offs.

## 3.2. Measure of OCD

The measure of OCD is the FOCI Severity Scale (Storch *et al.* 2007). Each question rates how much the subject has been bothered by each of the OCD-related symptoms during the past 7 days. An answer to each question is coded with 0, 1, 2, 3, or 4, representing none, mild,

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[17] The service offered by DataSpring Korea Incorporated is similar to that of Amazon Mechanical Turk in the United States. Similar to the service by Amazon Mechanical Turk, subjects are paid with fixed money for participation.

[18] Gender is 1 if male, 0 if female. Ln(Asset) is natural log(Asset), where Asset is in million KRW (Korean Won). Earning is monthly earnings. It takes the value of 6, 5, 4, 3, 2, 1, if monthly earnings is equal or above 8 million KRW, between 6 mln and 7.99 mln, between 4 mln and 5.99 mln, between 2 mln and 3.99 mln, between 1 mln and 1.99 mln, and below 1 mln, respectively. Field of occupations takes a value of 1, 2, 3, 4, or 5, if it is in finance, humanities, science or math, or related to other fields, respectively. Education is takes a value of 1, 2, 3, or 4, if the highest degree achieved is lower than a high school diploma, is a high school diploma, is an undergraduate degree, or is a masters' or PhD degree, respectively.

[19] These questions are aligned with the commonly used questions in the financial decision-making literature, i.e. Dohmen *et al.* (2010) and Frederick (2005).

moderate, severe, or extreme. Thus, the total score ranges from 0 to 20, where a higher score implies a more severe OCD.

## 3.3. Data

As shown in Table 1, the sample is of various demographic traits. 23.1% of the sample is diagnosed with OCD. The OCD score ranges from 0 to 19, out of the total score of 20. The mean score of the sample is 4.47. 7.6% of the answers to the questions involving decisions under risk and time are categorized as errors.[20]

**<Table 1. Summary Statistics>**

The table provides the summary statistics. Refer to Section 3 for variable definitions.

| Variable | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| Age | 827 | 35.6070 | 7.8349 | 24 | 54 |
| Gender | 827 | 0.5151 | 0.5001 | 0 | 1 |
| Asset (in million KRW) | 826 | 205.60 | 1298.06 | -1290.00 | 34990.00 |
| Ln(Asset) | 748 | 17.7097 | 2.0706 | 4.6051 | 24.2783 |
| Earning | 827 | 3.2237 | 0.9875 | 1 | 6 |
| Field of occupation | 827 | 4.0399 | 1.4277 | 1 | 5 |
| Education | 827 | 2.9733 | 0.4048 | 2 | 4 |
| ERROR | 827 | 0.0758 | 0.2259 | 0 | 1 |
| ERROR_risk | 827 | 0.0935 | 0.2601 | 0 | 1 |
| ERROR_5 | 827 | 0.0846 | 0.2785 | 0 | 1 |
| ERROR_50 | 827 | 0.1028 | 0.3039 | 0 | 1 |
| ERROR_95 | 827 | 0.0931 | 0.2908 | 0 | 1 |
| ERROR_time | 827 | 0.0580 | 0.2142 | 0 | 1 |
| ERROR_w | 847 | 0.0568 | 0.2317 | 0 | 1 |
| ERROR_m | 847 | 0.0641 | 0.2451 | 0 | 1 |
| ERROR_y | 847 | 0.0532 | 0.2246 | 0 | 1 |
| OCD | 827 | 4.4655 | 3.8343 | 0 | 19 |
| OCD Group | 827 | 0.2310 | 0.4217 | 0 | 1 |

## 4. Results

Table 2 shows pair-wise correlations, and the negative associations between OCD and measures of errors are apparent. As shown in Table 3, the probability of errors of OCD group is 13.2%, which is much higher than 5.9%, that of non-OCD group.

**<Table 2. Pair-wise Correlations between OCD and Variables of Errors>**

This table shows pair-wise correlation between variables of errors and OCD score. The positive association is apparent for all measures of errors. Refer to Section 3 for variable definitions. $^{*}$, $^{**}$, $^{***}$ indicate significance at 10%, 5%, and 1%, respectively.

| | ERROR | ERROR_risk | ERROR_time |
|---|---|---|---|
| OCD | 0.1566$^{***}$ | 0.1538$^{***}$ | 0.1435$^{***}$ |
| ERROR | 1 | | |
| ERROR_risk | 0.9611$^{***}$ | 1 | |
| ERROR_time | 0.9421$^{***}$ | 0.8129$^{***}$ | 1 |

[20] Also, 9.4% of the answers to the questions involving decisions under risk are categorized as errors. The probability of errors remains similar across measures involving different probability of winning. 5.8% of the answers to the questions involving decisions with time trade-offs are categorized as errors. Also, the probability of errors remains similar across measures involving different timespans. This supports the robustness of the measures of errors.

**<Table 3. Mean Comparison Tests by Group >**

This table presents the mean comparison tests for variables of error between OCD group versus non-OCD group. The average probability of errors is higher for OCD-group, compared to that of non-OCD group. Control variables are Ln(Asset), Earning, Field of Occupation, Age, Education, and Gender. Refer to Section 3 for variable definitions. *, **, *** indicate significance at 10%, 5%, and 1%, respectively.

| Variable | OCD Group (N=191 ) | Non-OCD Group (N= 636) | Difference & T-stat. | Difference & T-stat. (with all controls) |
|---|---|---|---|---|
| ERROR | 0.1318 | 0.0590 | 0.0728 (3.20)*** | 0.0792 (3.27)*** |
| ERROR_risk | 0.1640 | 0.0723 | 0.0917 (3.46)*** | 0.1012 (3.60)*** |
| ERROR_time | 0.0995 | 0.0456 | 0.0539 (2.56)** | 0.0572 (2.54)** |

Table 4 presents the results of OLS regressions. OCD has significant explanatory power in explaining variables of error in all specifications. Approximately 10 score increase in OCD (out of the total score of 20) is associated with about 10% higher chance of making errors.

**<Table 4. Coefficient Estimates in OLS Regressions >**

This table presents the coefficient estimates of OCD in OLS regressions in various regression specifications. OCD has significant explanatory power in explaining variables of error in all specifications. Demographic controls are Ln(Asset), Earning, Field of Occupation, Age, Education, and Gender. Refer to Section 3 for variable definitions. *, **, *** indicate significance at 10%, 5%, and 1%, respectively.

| | Dependent Variable = ERROR | | Dependent Variable = ERROR_risk | | Dependent Variable = ERROR_time | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **OCD** | **0.00922 (4.15)***** | **0.00917 (3.88)***** | **0.01043 (4.08)***** | **0.01065 (3.98)***** | **0.00801 (3.90)***** | **0.00769 (3.45)***** |
| Demographic Controls | X | V | X | V | X | V |
| N | 827 | 748 | 827 | 748 | 827 | 748 |
| R-Squared | 0.0245 | 0.0702 | 0.0236 | 0.0658 | 0.0206 | 0.0638 |

# 5. Conclusions

The results of this paper show the positive association between OCD and the probability of making errors in financial decisions. Note that these are preliminary results without detailed analyses on the potential causal relations as well as underlying structural reasons. Further evidence on the potential causal relations can be examined going forward. Also, potential explanations of such a relation in terms of relevant fields, i.e. neuroscience, can be studied going forward.

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