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An Empirical Analysis on Individuals' Deposit-Withdrawal Behaviors Using Data Collected through a Web-Based Survey

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Abstract

The purpose of this paper is to investigate relationships between individual depositor behaviors, as to whether they will withdraw all of their deposits, and factors behind them such as the degree of trust in information sources, frequency of communication, individuals' transaction with banks, and individuals' attributes. By doing so, we suggest possible countermeasures whereby depositors will not excessively withdraw their deposits after receiving uncertain information on the financial environment. In this paper, we analyze the relationships by using data collected through a Web-based survey. The results were as follows: First, individuals who trust in information sources such as weekly/monthly magazines, the Internet, and conversations with people at workplace would be more likely to withdraw their deposits. Second, increases in phone calls with friends and in communication frequency at neighborhood and workplaces also make depositors to withdraw funds. Third, their tendency to withdraw deposits is affected by the individuals' attributes such as gender and education. As the recognition of the deposit insurance scheme among people seems to affect their behavior according to our analysis, we suggest that it is better that authorities advertise the function of deposit insurance schemes to prevent depositors from getting into a panic situation like bank run.

Keywords: *Depositor behaviors, psychological factor, communication, logistic regression analysis, Web-based survey*

JEL Classification Codes*:* C25, C91, Z13

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Introduction

How do you behave if you hear that the financial institution where you keep your money is about to fail? Are you likely to withdraw your money from the account, if you can? Are you likely to pass the rumor of bank failure to your friends, colleagues and family even if the rumor is not credible? Actually, bank run cases exist in Japan because of a non-credible rumor in the past (Nagaoka and Takemura, 2009).

Is it inevitable for depositors to withdraw all of their money if such a situation occurs? Unless appropriate countermeasures are taken, the economy and the market might become unstable, and a panic might spread to other countries. It is sometimes said that the worldwide financial crisis is caused by a delay of new effective countermeasures. Banks, financial authorities and governments therefore should discuss appropriate prior and posterior countermeasures for any possible serious stresses. Especially, it is important that the countermeasures should be based on some scientific analysis, not on just historical or non-scientific approaches. It is indeed difficult to respond to a crisis swiftly enough if a truly unexpected situation occurs. In the meantime, most academic researchers and economists are very much interested in the financial crises that have occurred recently all over the world, and they analyze economic developments from various viewpoints. Many macroeconomists believe in their ability to clarify the reasons for financial crises by their macroeconomic models and to suggest policies based such models. Of course, it is clear that macroeconomic indexes, such as stock prices and the growth rate of the GDP, affect the economy as a whole and people's behavior in the financial market. However, it might be doubtful that macroeconomics can correctly capture people's behavior in a panicky situation.

Therefore, in this paper, our challenge is to create a model to study decision-making of individuals who may withdraw their deposits. This paper investigates the factors that affect individuals' decision to withdrawal deposits. By exploring such factors, we believe that banks, financial authorities and governments can obtain ideas of both prior countermeasures against bank runs and posterior countermeasures for cases where a bank run unfortunately occurs. For this purpose, we analyze the possible behavior of depositors by using data collected through a Web-based survey we conducted in 2007. Research at the individual level is still in an exploratory stage and the accumulation of data so far has been small.

The backgrounds of our research are: First, quantitative analyses on the behavior of depositors have not yet been done so many. Second we think that analyses based on modeling within microeconomic framework should be supported more broadly in order to enhance the process of actual policy designing. Third, psychological perspectives of depositors have not been analyzed much in economics fields because most researchers have been interested in the cases where the miss

management of banks, not the behavior of individuals, had been the cause of bank failures.

This paper is organized as follows. Section 2 introduces previous works on financial crises and bank runs. Next, we present our model and explain the statistical method and data set in section 3. Section 4 shows the estimated results and the implications. Finally, we conclude remarks and point out future work in section 5.

2. Literature Review

There are many researches which use various economic approaches on financial crises. Almost all of them studied the effects of policies against financial crises from macroeconomic perspective, for example, Choe and Lee (2003), and Pathan, Skully and Wickramanayake (2008). They verify what kinds of long-term financial impacts on markets were brought by the policies regarding bank restructuring during financial crises. On the other hand, from a microeconomic perspective, a very few researches on financial crises have been accumulated. In other words, almost any of the previous quantitative researches on financial crises were not based on models at the individual level. Only a few researchers, such as Yada, Washio, Ukai and Nagaoka (2008), and Takemura and Ukai (2008) made models at the individual level. Yada, Washio, Ukai and Nagaoka (2008) modeled a bank run during a financial crisis. They built a model where depositors withdraw their deposits, using data-mining approach as an estimation technique, and by this model they estimated possible deposit withdrawal amounts in case of financial crises. They estimated the total deposit withdrawal amounts at a branch when depositors come to have doubts on the bank's solvency, and they verified significant differences on the estimations of total deposit withdrawal amounts, depending on the location and on the major depositor groups of the branches. Takemura and Ukai (2008) modeled a decision-making process where individuals determine whether or not to withdraw their deposits after receiving uncertain information on the financial environment. They estimated parameters of various attributes in their model by using a statistical method. The authors mentioned the need for a model that covers psychological factors and economic variables that do not directly related to the decision- making on withdrawal of deposits. Our paper is based on this research.

We think the models based on a microeconomic perspective is richer than those research based on a macroeconomic perspective in the sense that the former reflect more information with regard to an individual's (unexpected) behavior. Thus, in this paper, analyses are based on a microeconomic perspective.

Finally, let us introduce historical researches on financial crises; Nagaoka and Takemura (2009), and Shiller (2008). These researches are also important when we analyze the financial crises from the viewpoints of economics.

3. Framework

3.1. Model/Statistical Method

The purpose of this paper is to investigate relationships between individual depositor behaviors, regarding whether they will withdraw all of their deposits, and factors behind them, such as the degree of trust in information sources, frequency of communication, individuals' transaction with banks, and individuals' attributes. By doing so, we suggest possible countermeasures whereby depositors will not excessively withdraw their deposits after receiving uncertain information on the financial environment.

For a long time, logistic regression has been widely used for building a decision-making model as a statistical method to grasp the relationships among explanatory variables and explained variables in many fields like psychology, sociology, economics, and business administration. Generally, a logistic regression model consists of an explained variable p which is a probability that a certain event happens, and explanatory variables as co-variables that influence p. Note that p follows logit distribution, logit(p)=log(p/1-p).

In this paper, we build a model by binary logistic regression analysis[1]. In our model, the explained variable p is the probability that individuals withdraw all of their deposits after receiving uncertain information on financial environment and explanatory variables are grouped roughly as follows: 1) degree of trust in information sources, X_1, 2) frequency of communication, X_2, 3) individual transactions with banks, X_3, and 4) individuals' attributes, X_4. Section 3.2 will explain these variables in detail.

The relationship between the explained variable and the explanatory variables is simply described by equations (1) or (2).

$$p = \exp[a+b_1X_1+b_2X_2+b_3X_3+b_4X_4]/(1+ [a+ b_1X_1+ b_2X_2+ b_3X_3+ b_4X_4]) \quad (1)$$

or,

$$\log(p/1-p)=a+ b_1X_1+ b_2X_2+ b_3X_3+ b_4X_4 \quad (2)$$

Note that we can obtain equation (2) by taking the logarithm of both sides of the equation (1).

Our model expressed by equation (2) is incorporating not only economic variables, but also psychological ones in the decision-making of depositors. We assume that

[1] Originally, it is necessary to think about various choices depend on the degree of uncertainty, and to build a model by multinomial logistic regression analysis. However, we can only obtain binary data concerning whether or not to withdraw their deposits in the survey. Therefore, in this paper, we build a model by binary logistic regression analysis.

depositors would be strongly affected by psychological factors if they encounter a financial panic situation such as a bank run.

In general, many economic models using micro data take up only various economic variables such as revenue, asset, investment, consumption, and so on. Such models are meaningful but they seem not to capture some charm of reality. We think that it important to incorporate psychological factors into economic analyses[2]. Micro data are particularly useful when we analyze a panicky situation in an economics framework[3] and we will be able to build a richer model of economic behavior with them.

The explained variable on the left side of equation (2) represents a logarithm odds ratio. This can be interpreted as the degree to which individuals are apt to withdraw all of their deposits[4.] Also, the coefficient parameter of each explanatory variable on the right side represents a logarithm odds ratio when the explanatory variable changes one unit. For example, if X_j with the ordinary property changes one unit and the coefficient parameter b_j is positive (resp. negative), then individuals are apt to (resp. not to) withdraw all of their deposits after receiving uncertain information on financial environment. A bank run will occur if enough number of individuals withdraw their deposits, and such a situation is a risky one for banks.

Here, we introduce methods and processes to estimate coefficient parameters in equation (2), and to evaluate the fit of our model. To estimate each coefficient parameter in equation (2), we use the general maximum likelihood estimation method based on a binominal distribution. As the calculation of the estimations is too complex, we use a statistical computer software in this paper[5]. SPSS has a) a forceful method for inserting explanatory variables, b) a variable increase (decrease) method by likelihood ratio, c) a variable increase (decrease) method by Wald, and d) a conditional variable increase (decrease) method as a method of variable selection. Among these methods, we apply the variable increase and decrease methods by likelihood ratio for variable selection. This method is often used as one of the most preferable indexes[6.]

We run the Hosmer-Lemeshow test to evaluate the fitness of our model. Note that the null hypothesis H_0 here is that the model is well suited[7]. In addition, we

[2] Many macroeconomic models fail to incorporate psychological factors.
[3] In other words, it is natural to assume that depositors' behavior is not just a result of decision-making with economic rationality in case of a panicky situation.
[4] An odds ratio is a statistical measurement showing the odds of an event occurring in one group to the odds of it occurring in another group.
[5] We use SPSS version 17.01J for Windows, SPSS, Inc..
[6] It would be preferable to use a variable stepwise method by likelihood ratio, but unfortunately, SPSS does not contain this method.
[7] Refer to Hosmer and Lemeshow (2000) about the details of this test.

evaluate the validity of the model by using a positive distinction rate, which measures the fit of this model[8].

In this paper, we run both variable decrease/increase methods by likelihood ratio and compare the results. Then we synthetically evaluate the results from the viewpoints of fit and validity.

3.2. Dataset

We use the data collected through a Web-based survey, which is a questionnaire survey via the Internet[9]. The data collection period was September 8 to 9, 2007. The sample size is 1500. The collected data include over 50 properties such as gender, age, education, and the attributes related to possible bank runs, such as recognition of deposit insurance scheme, income level, total amount of deposits, and so on. In this paper we use a part of these properties.

Compared with other social surveys, statisticians and researchers who conduct social surveys point out that Web-based survey has various biases because the collection method is not necessarily random sampling. Such suggestion is correct and trial to overcome this problem is quite important. Recently some researchers have been trying to develop methods and procedures to adjust such biases[10]. However, a common method for that has not yet established and therefore we do not explicitly discuss this problem of the bias of Web-based surveys in this paper. We think there are trade-offs among several ways of social surveys[11.] For example, random sampling is generally adopted in mail surveys and telephone surveys but the rate of recovery has decreased rapidly in recent years and the cost of the surveys becomes too expensive[12]. On the other hand, the cost of Web-based surveys is less expensive than the other ways of social survey and a lot of samples can be collected in a short period.

3.2.1. Individuals' deposit withdrawal behavior

The event for the explained variable in equation (2) is: Whether an individual will withdraw his or her entire deposit or not after receiving uncertain information on

[8] The higher the positive distinction rate, the more correctly fits the model.

[9] The data we have collected can be used all over the world for research purposes by applying to the Research Institute for Socio-network Strategies (abbreviation, RISS), Kansai University. Our data, can be accessed through the Website (http://www.kansai-u.ac.jp/riss/en/shareduse/database.html), or by direct contact.

[10] Refer to Hoshino (2007), for example.

[11] Ohsumi (2002) gives some suggestions on the limit and the possibilities of Web-based surveys in the future.

[12] In addition, it becomes very difficult to conduct mail surveys and phone surveys in Japan because of the implementation of the individual information protection act. Recently the number of social surveys via the Internet is increasing and it seems that in the near future Web-based surveys will become the most popular way.

the financial environment. Other actions such as withdrawal of part of the deposits are not considered here. Thus, the explained variable in equation (2) is defined as follows:

p = 1 if the individual withdraws deposits,

= 0 otherwise,

where p represents the probability that the individual withdraws deposits.

The distribution for withdrawing all deposits is shown Figure 1.

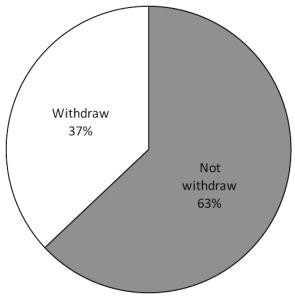


Figure 1: Distribution for withdrawing all deposits

3.2.2. Degree of trust in information sources

We assume information sources as 1) TV, 2) newspapers, 3) weekly/monthly magazines, 4) Internet, 5) e-mail or phone calls with friends, 6) conversations with neighbors, and 7) conversations with people at the workplace.

The degree of trust in these information sources X_{1j} (for j = 1, …, 7) are measured by the following 5 ordinal indexes: (1) I never trust the information source, (2) I do not trust it at all, (3) I am indifferent of trusting the information source, (4) I weakly trust it, and (5) I strongly trust it[13].

The distribution on each degree of trust in information sources is shown in Figure 2.

[13] Similarly, Takemura and Ukai (2008) analyze the depositors' behavior including the Yamagishi and Yamagishi measurement on psychological factors. Also see Yamagishi and Yamagishi (1994).

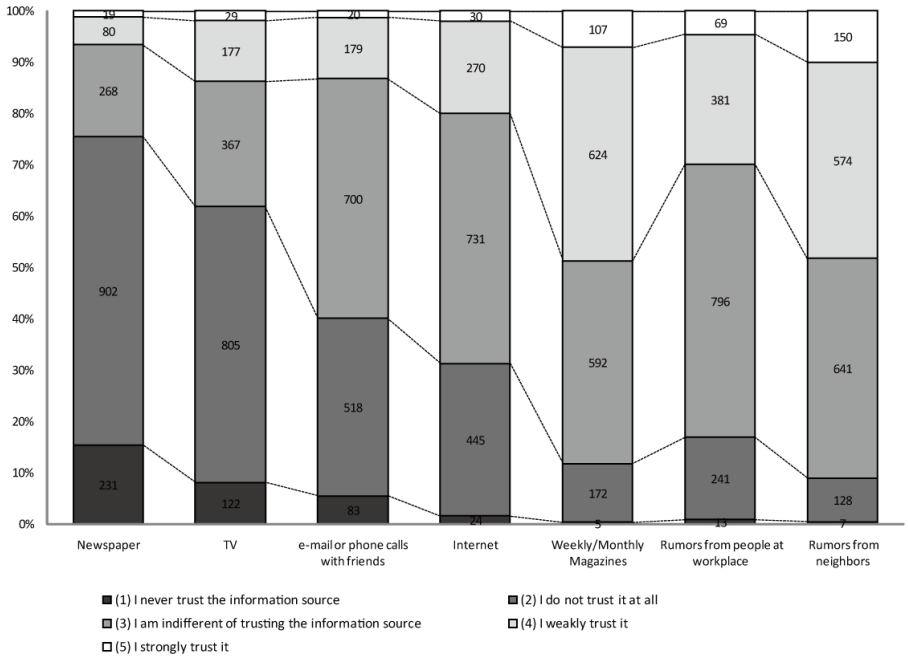


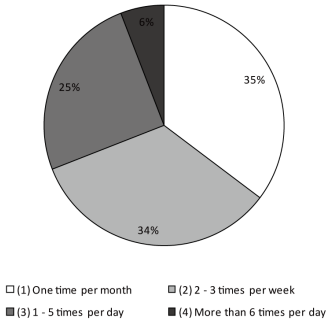
Figure2: Degree of trust in information sources

3.2.3. Frequency of communication

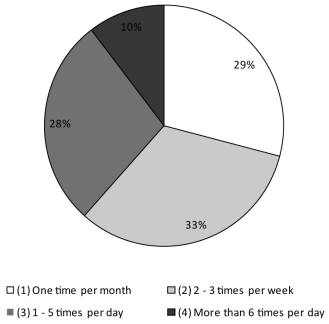
We also asked frequencies of communications with regard to phone calls, e-mail with friends and communication with neighbors and communication with people at the workplace. The results are shown in Figures 3.

From these tables, it can be found that regarding the frequency of communication with people at the workplace the majority is more than two times per one day, which is a lot, and with the other communications the frequencies are not as much.

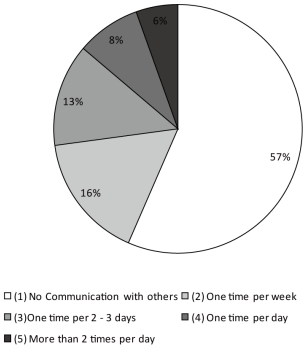
In equation (2), X_{2m} (m = 1, 2, 3, 4) represents the frequency of communication. When m=1: it is the frequency of phone calls, m=2: the frequency of e-mail with friends, m=3: the frequency of communication with neighbors, and m=4: the frequency of communication with people at the workplace. With respect to phone calls and e-mail with friends, the frequencies are measured by the following ordinal indexes. For one time per month: 1, for 2 - 3 times per week: 2, for 1 - 5 times per day: 3, and for more than 6 times per day: 4. With respect to the communications with neighbors and people at the workplace, for no communication with others: 1, for one time per week: 2, for one time per 2 - 3 days: 3, for one time per day: 4, and for more than 2 times per day: 5.



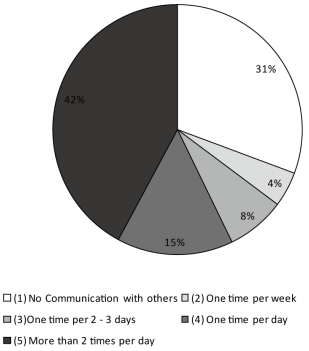
Frequency of phone calls



Frequency of e-mail with friends



Frequency of communication with neighbors



Frequency of communication with people at the workplace

Figure 3: Frequency of communication

3.2.4. Transactions of individuals with banks

To capture the transactions of individuals with banks, we use the following variables; number of bank accounts, total amount of deposits, ratio of term deposits in total amount of deposits, type of main banks, annual income, and recognition of the deposit insurance scheme . You can refer to Takemura and Kozu (2009) about details of elementary statistics on above variables.

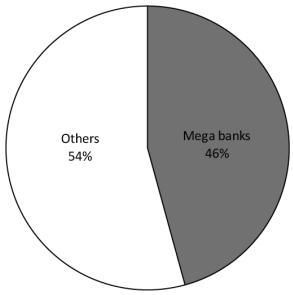
Type of main banks is defined by using the following indicator function:

X_{3B} = 1 if the depositor's main bank is a mega bank including Yucho bank,
= 0 otherwise.

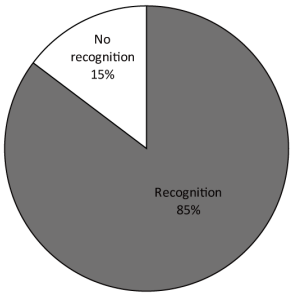
In addition, the recognition of the deposit insurance scheme is defined as follows:

X_{3R} = 1 if the depositor recognizes the deposit insurance scheme,
= 0 otherwise.

Figures 4 shows the distributions of the type of main bank and recognition of the deposit insurance scheme.



Type of main banks



Recognition of deposit insurance scheme

Figure 4: Transactions of individuals with banks

3.2.5 Individuals' attributes

As the variables for individuals' attributes, we chose gender, age, education, living area in Japan, marriage status, and type of employment.

Gender is defined as follows:

X_{41} = 1 if the depositor is male,

= 0 otherwise.

Education is an ordinal variable. The value grows as the education level goes up.

Tables 1 and 2 shows the distributions of gender and education. Note that you refer to Takemura and Kozu (2009) about details of above the other variables.

Table 1: Gender

	Number	Percentage
Male	765	51.0
Female	745	49.0
Total	1500	100

Table 2: Education

	Number	Percentage
1) graduation from Junior high school	32	2.1
2) graduation from Junior college and high school	560	37.5
3) graduation from career college	15	1.0
4) graduation from higher professional school	199	13.3
5) graduation from university	604	40.4
6) graduation from Graduate school	85	5.7

4. Estimated Results and Implications

In this section, we estimate the coefficient parameters in equation (2) by running both the variable decrease method and the variable increase method by likelihood ratio. First, we use 23 explanatory variables that we introduced in section 3, which are summarized in Table 3.

Table 3: Explanatory variables' descriptions

Variable name	Description
X_{11}	TV
X_{12}	Newspapers
X_{13}	weekly/monthly magazine
X_{14}	Internet
X_{15}	e-mail or phone calls with friends
X_{16}	conversations with neighbors
X_{17}	conversations with people at the workplace
X_{21}	frequency of phone calls
X_{22}	frequency of e-mail with friends
X_{23}	frequency of communication with neighbors
X_{24}	frequency of communication with people at workplace
X_{31}	the number of bank accounts
X_{32}	type of main bank
X_{33}	total amount of deposits
X_{34}	ratio of term deposit in total amount of deposits
X_{35}	annual income
X_{36}	recognition of deposit insurance system
X_{41}	Gender
X_{42}	Age
X_{43}	Education
X_{44}	living area
X_{45}	marriage status
X_{46}	type of employment

The results are that 9 out of the 23 variables survived through the variable decrease method examination and that 8 variables survived through the variable increase method examination. The estimations are shown in Tables 4 and 5, respectively. Note that in these tables b_{41} is the estimated coefficient of X_{41}, for example, and others are corresponding in the same way.

Comparing tables 4 and 5, we can find the following: First, the estimated coefficient parameters of the degree of trust in information sources, which are weekly/ monthly magazines, the Internet, and rumors form people at the workplace, are statistically significant and positive. Second, the estimated coefficient parameters of the frequency of e-mail with friends, the frequency of communication with people in the neighborhood and workplace are statistically significant and positive.

Table 4: Estimated result I - variable decrease method -

	B	Standard error	Exp(B)
b_{13}	0.161	0.075	1.174
b_{14}	0.169	0.078	1.184
b_{17}	0.224	0.073	1.251
b_{22}	0.205	0.062	1.228
b_{23}	0.093	0.046	1.097
b_{24}	0.086	0.034	1.090
b_{36}	-0.280	0.155	0.756
b_{41}	0.264	0.118	1.302
b_{43}	0.102	0.038	1.108
Constant term	-3.257	0.414	0.039

Table 5: Estimated result II - variable increase method -

	B	Standard error	Exp(B)
b_{13}	0.158	0.075	1.172
b_{14}	0.173	0.078	1.189
b_{17}	0.224	0.073	1.251
b_{22}	0.212	0.061	1.236
b_{23}	0.091	0.046	1.095
b_{24}	0.085	0.034	1.089
b_{41}	0.282	0.118	1.326
b_{43}	0.096	0.038	1.101
Constant term	-3.497	0.394	0.030

Third, on the individuals' transactions with banks, the estimated coefficient parameter of the recognition of the deposit insurance scheme is statistically significant and negative only in the case of the variables decrease method. On the individuals' attributes, the estimated coefficient parameters of gender and education are statistically significant and positive. On the other hand, those of other explanatory variables are not statistically significant.

From the results of the Hosmer-Lemeshow test which are shown in Tables 6 and 7 below, we can evaluate the fit of these models. The both models are 5% or more significant. In addition, we can say the both models are valid also because the positive distinction rate turns out to be between 64.1% and 65.5%.

Table 6: Hosmer-Lemeshow test I (variable decrease method)

Chi 2 Square	Degree of freedom	Significance probability
9.742	8	0.284

Table 7: Hosmer-Lemeshow test II (variable increase method)

Chi 2 Square	Degree of freedom	Significance probability
2.995	8	0.935

We think these results in this work are meaningful. The psychological aspect is important in our model, that is, we expect that psychological factors become binding when individuals are to withdraw their deposits after receiving uncertain information on the financial environment. In particular, those who withdraw deposits easily are people who trust informal information, not formal one. Moreover, when the frequencies of e-mail with friends, and of communications with people in the neighborhood and at the workplace are higher, the probability that such individuals will withdraw their deposits becomes also higher. In sum, it could be expected that the individuals who have the above mentioned characters would be more likely to withdraw their deposits after receiving uncertain information on the financial environment. This type of individuals could be expected, when they feel uncertain on the financial environment, not only to withdraw their own deposits, but also to convey their worries to the people around them. It could be said that this chain of uneasiness may lead to a more serious panicky situation in general.

Meanwhile, we find that economic valuables such as annual income and total amount of deposit are failed to be incorporated in our model. This might be a puzzling result for some economists, especially for macroeconomic researchers. It is usually very difficult to describe a financial panic by the macroeconomic models which consist of various economic variables and some of them are controlled. Thus most macroeconomic models fail to present implications for the prevention of financial panics like bank runs. This seems to show one limitation of traditional macroeconomic modeling with no micro agent level considerations. Furthermore, we might be able to say that this limitation would be related to the widely accepted assumption that the agent always behaves rationally.

We also found that people who recognize the deposit insurance scheme are less likely to withdraw their deposits even if they receive uncertain information on the financial environment. This would be good news for the authorities because they may prevent depositors from withdrawing their deposits carelessly by advertising the function of deposit insurance schemes. Note, however, that this result is only significantly supported when we take the variable decrease method.

In addition, gender and education, which are individuals' attributes, are binding according to our results. We also find that males tend to withdraw their deposits more easily than females and highly educated people would be more likely to withdraw their deposits than the less educated.

5. Concluding Remarks and Future Work

In this work, we statistically investigated the relationships between the behaviors of individual depositors, as to whether or not they will withdraw all of their deposits, and factors behind them, such as the degree of trust in information

sources, frequencies of communication, individual's transactions with banks, and individuals' attributes.

The main results are the following: First, individuals who trust in information sources such as weekly/monthly magazines, the Internet, and rumors from people at the workplace will be more likely to withdraw their deposits. Second, increases in phone calls with friends and in communication frequencies at neighborhood and workplace will also lead to more withdrawals. Third, when depositors receive uncertain information on the financial environment, their tendency to withdraw their deposits is affected by the attributes of individuals such as gender and education.

One of the implications of these results is that banks and authorities have to pay attention to information sources which individuals frequently use. If the chain of uneasiness could be blocked with such knowledge, it might be possible to avoid unnecessarily panics. A panicky situation like a bank run would occur when uncertain information is communicated and spreading out. Authorities could also take countermeasures as a part of a business continuity plan (abbreviation, BCP) if they know in advance how the chain of uneasiness noted above works.

Meanwhile, economic variables such as annual income and total amount of deposit turn out to be not statistically significant in our analysis. This may indicate that micro data oriented approaches are more useful than traditional macroeconomic models in describing a panicky situation of the economy. Further researches are needed hereafter to improve the models using data at the individual level.

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