An Experimental Analysis of Time Inconsistency Caused by Regret Aversion*

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Abstract

This paper studies whether decision maker reveals regret aversion caused by opportunity dependence or not, via experimental methods. The opportunity dependence is not broadly observed when they confront perfectly objective choice sets. Some agent induced to the braking condition of independence irrelevant alternative (IIA). Making some constraint of asset choice does not matter strongly in portfolio selection. Most subjects keep their strategy.

We can conclude opportunity dependence caused by ex-post regret aversion occurred within minority.

1 Introduction

1.1 Background

This is an experimental research on dynamic inconsistency of decision making under uncertainty caused by regret aversion.

The well known choice by regret aversion is Savage's minimax regret choice. It violates the IIA, which is one of the necessary condition of rational preference. (For example, see Arrow [1])

Minimax regret choice leads to the violation of axiom of revealed choice: the selected choice from a large set is not necessarily the best from a smaller set including by that large set. For example, the best student of Keiai University that has faculty of

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Economics and International may not be the best student of the Faculty of Economics of Keiai University.

Regret aversion is possible to be one reason of opportunity dependent choice. We describe it as below.

In the context of the financial market, the regret aversion is known as one kind of behavioral anomaly. One typical case is when an investor sticks to the same strategy even if some obvious change has occurred in the market: even in the case when they should change their position, they are afraid that the matter could become worse just after they move their position. Consider the case if the stock price became higher just after they sold it. They anticipate their ex-post regret, and for them, 'to wait and see' is the best strategy to evade such types of regret. Regret aversion has been focused in such pessimistic context. Recently, however, an aggressive strategy may be explained by regret aversion. Actually, we sometimes observe aggressive strategy in peoples behavior in real life: choice of university entrance examination and confession of one's love to another.

We are interested in the latter features of regret aversion and tried to find it in our experiment.

1.2 Related literature of experiment

Choice dependent is broadly found as reason-based choices. For example, Shifre, Tversky and Simonson [12] found some choice dependency in consumer choices that violated the weak axiom of revealed preference.

For example, they found the answer, 'I would like to reconsider and not buy now,' increase when alternatives are added. This shows that the rationality of revealed choice is broken: the best answer from a large choice set do not become the best choice from a smaller choice set included in a large choice set.

Izawa [7] investigates the regret aversion by experimental method. He uses questionnaires with quasi stock market experience of subjects. He asks subjects thier feelings before and after investment in the virtual stock market in the laboratory. He points out the aspect of dynamic inconsistency caused by regret aversion. He introduces the revised utility function including ex-post regret aversion and finds that regret aversion leads investors to more aggressive and that demands for stocks

increased compared to the case without regret aversion in his experiment.

By empirical data analysis, we could not distinguish usual demand for risk security and demand created by regret aversion for following reasons. The choice by regret aversion in actual security market is affected by temporal information. Regardless of the information, the regret aversion makes the investor to be both bull and bear if the market has no constraint to short sell.

Hayashi [8] focus as on two aspects of regret aversion caused by opportunity dependence.

One example is named 'non-binding constrains matter'. When an investor is moved by anticipated ex-post regret, relaxing or tightening binding constraints of portfolio matter his selection in contrast to the prediction of rational expectation theory.

When some option is added to the portfolio, the portfolio selection may be revised in the way in breaking the weak axiom of revealed choice. For example, consider the case when new stock brands are listed on the market. The attitudes of investors may change to ex-post regret aversion due to regretting not investing that brand new stock. For the same reason, some limitation or new principle to invest makes the investors aggressive or pessimistic.

The short sale constraint has been frequently discussed in view of the efficiency of the market. The possibility that the stock price is affected by the short sale limitation is intuitively obvious because this limitation makes information or strategy become asymmetric. Regret aversion with systematic limitation also brings some asymmetric aspects by changing the benchmark of the investors. The importance of benchmark for investors is known in behavioral finance.

2 Experiment

2.1 Experimental Method

We used two types of experimental methods A and B to observe different aspects. We separated subjects into two groups. Our aim is to observe between groups differences.

2.1.1 basic data

execution day	No .of subjects	Subjects	Types of Experiment
11 January 2007	48	Keio University	A1,A2 and B

2.2 Different Choice Sets Made by Lotteries

Our procedure is as follows. We make 2 groups to compare the results between groups. Group A,C and B,D face different types of choice sets including at least two of the same lottery tickets choice set. The subjects can only choose one of 2 or 3 alternatives a,b, or c, in experiment A and they cannot choose the states, red or blue. The same things are held in experiment B, the subjects can only make their own portfolio using given choice sets, however, they cannot choose the states.

In this experiment, the choice sets are substitution of the market security and the states expressed by colors shows market fundamentals.

2.2.1 Experiment A between and within groups

In this experiment, we try to observe the aggressive attitude caused by opportunity dependence. The two groups are given different choice sets including two or three lottery tickets.

We use choice sets $A1$ (a, b), $A1' = (a, b, c)$, $A2 = (d, e)$, $A2' = (d, e, f)$. We call experiment A including alternatives between A1 and A1' and so on (See table 1)
It is obvious that $A1 \subset A1'$, and $A2 \subset A2'$.

We carry out this experiment in two ways. The first objective is to observe whether each subject's consistency is kept or not. If opportunity dependence caused by regret is observed, consistency is broken. We intend to observe each subject's consistency. We also intend to observe between each groups consistency. This is a standard and appropriate method to test our hypothesis: subjects behave to evade regret.

In experiment A, the lottery ticket is made as figure 1.

The number on the lottery tickets under the red circle indicates the amount they will get if the red card is drawn form the box. The number on the lottery thickets under the blue circle indicates the amount they will get if blue card is drawn from the box. The possibility of drawing red and blue is 50 per cent. On the tables 1 and 2, the

mark of * attached to the number shows best reward when red is drawn by the experimenter, and ** shows the best reward when the blue card is drawn. Regret by state is calculated by eliminating the reward from each best reward. For example, group A and B are given the choice set made by lottery tickets a and b, and if red is drawn, by experimenter, the lottery b's reward of 1600 is the best reward. In this case if subjects select lottery ticket < a >, they feel regret by 1600 − 800 because they got 800, however, the reward is smaller than the best reward in their choice set. If subjects are risk neutral, Savege's minmax regret principle makes subjects to select lottery b. However, some subjects may be risk averse, therefore we can expect that lottery < a > will be selected because the expected is only 200 yen larger than when subjects choose lottery < b >.

Our aim of experiment A1 is to observe the shift from the lottery < a > to < b > when < c > is added. Lottery < c > is added to change the most attractive lottery ticket if subjects are moved by regret. If subjects make their decision by usual expected utility theory, they will select with their own risk attitude: risk averse, risk neutral, or risk loving. For example, if a subject in group B would be risk averse, he is considered to select lottery ticket < a > because this lottery is perfectly safe. If he would be risk neutral, he will select < b > because the expected value of lottery B is 900, which is slightly larger than < a >. However, in group B and D, a subject who is risk neutral will select < c > because the < c > has the largest expected value. Notice that lottery ticket < c > is risky because there is half the possibility they could lose their reward for participation.

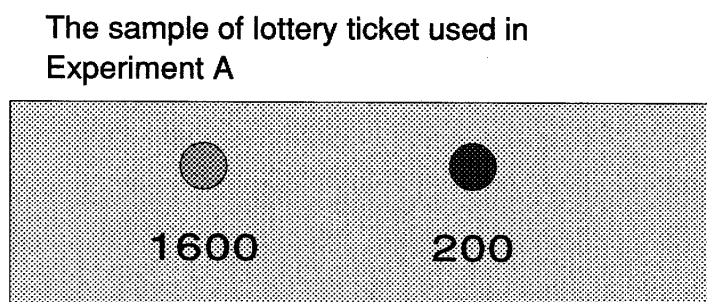The sample of lottery ticket used in
Experiment A

Figure 1: The lottery thicket used in experiment A

The opportunities we give subjects are as below.

Experiment A2 is made to compare the results with A1. In A2, the add choice alternative lottery $< f >$ dose not change the maximum regret from the choice set because (500, 1100) is not superior to (900, 700) and (300, 1500) ex post. If red is drawn, the lottery $< d >$ is superior to $< f >$ and if blue is drawn, the lottery $< e >$ is superior to $< f >$. Therefore we consider that choices of subjects do not change.

2.3 Experiment B: Different Choice Sets Made by Coupon selection

We also examine whether opportunity dependence will occur by ex-post regret using coupon selection. This experiment is to observe the violation of rational choices in the context of investing money in the security market.

We prepare two types of coupons. The blue coupons are safe and subjects are payed 200 yen after the experiment. We call these safe coupons. The red coupons are not safe and subjects are payed 500 yen for 40 per cent and 0 yen for 60 per cent. The reward from the red coupon is decided in a probabilistic way. We call these risky coupons.

We give each subject 15 coupons in a treatment with restriction and 20 coupons in a treatment without restriction. See table 3. We give 20 coupons to the subjects of group A and C in the first treatment, and 15 coupons in the second treatment. Therefore, they face the larger choice set in the first, and then they face the smaller choice set. We give 15 coupons to the subjects of group B and D in the first treatment, and 20 coupons in the second treatment. Therefore, subjects face the small choice set in the first, and then

groups	group A, B and C		group A, B and D	
choice set	A1 = (a b)		A2' = (a,b,c)	
reward or regret by state	reward	regret	reward	regret
state	(red, blue)	(red, blue)	(red, blue)	(red, blue)
choice alternative a b c	(800, 800**) (*1600, 200) —	(800, 0) (0, 600) —	(800, 800**) (1600, 200) (*3200, −1000)	(2400, 0) (1400, 600) (0, 1800)

Table 1: The choice sets used in experiment A1

200

groups	group A, C and D		group B, C and D	
choice set	A2 = (d,e)		A2' = (d,e,f)	
reward or regret by state	reward by state	regret by state	reward by state	regret by state
state	(red, blue)	(red, blue)	(red, blue)	(red, blue)
choice alternative d e f	(*900, 700) (300, 1500**) −	(0, 800) (600, 0) −	(*900, 700) (300, 1500**) (500, 1100)	(0, 800) (600, 0) (400, 400)

Table 2: The choice sets used in experiment A2

group	safe coupon	risky coupon	type of treatment
A, B, C, D	10	10	restriction free
A, B	10	5	restriction for risky asset
C, D	5	10	restriction for safe asset

Table 3: Coupon selection with or without restriction in experiment B

they face the larger choice set.

We make subjects to form their portfolio using 10 coupons in each treatment. Our intention of this experiment is to observe portfolio selection with and without restriction. In the security market, short sale restriction is said to be the source of asymmetric pricing. We are interested in the situation where constraint moves the subjects to change their portfolio.

2.4 Procedure of Experiment

2.4.1 Basic procedure

In experiment A and B, we use envelopes. We enter the choice alternatives into envelopes. Each subject receives one envelope and when they open it, they will find 2 or 3 lottery tickets. They select one lottery and enter it into the envelop. After they write the name, we collect all the envelopes.

The choice alternatives each subject received are double randomized in each choice set. First is done by the experimenter when making envelopes and the second is done by the subject when opening and picking each lottery ticket.

The first aim is to see whether breaking axiom occurs or not within subjects. Our second aim is to see test the differences of answers between groups.

We pay attention to ensure that each subject dose not try to keep consistency when they notices the similarity of choice set. Some subjects in group B and D may notice that one choice set they already received is included in the choice set they receive later. Some subjects in group A and C may notice that the choice set they already received, are subsets of the choice set they receive later. The subjects may try to keep their consistency because they are afraid they are thought to be irrational. Therefore, we give each subject the envelope including different types of choice sets, between large choice sets and the subset of it.

2.4.2 The procedure to decide rewards

The reward is fixed by two procedures.

First, one question is selected in Experiment A and B.

Experiment A requires 3 questions to each subject, however, only 1 envelope means one choice set is selected for paying reward. The contents of the envelope depends on the group, so the lottery subjects confronted are different in each group.

Next, the state is decided after all decisions are made by subjects. The 5 red and 5 blue cards are entered in one box, and one card is drawn by the experimenter.

Each subjects is to receive money written in the selected lottery ticket by the state in the experiment A.

Experiment B requires the subject to answer two questions: making portfolio uses 10 coupons out of 20 coupons and also 10 out of 15 coupons. These treatments correspond to the decision makings without and with restriction. The next final procedure of experiment B is to select a treatment to pay reward. The final procedure is to decide the reward from risky coupons. The 10 cards are entered in one box, 4 are red and 6 are black tramp cards. If a red card is drawn, the risky red coupon turns out 500 yen for each coupon. And if a black card is drawn, nothing is payed. The blue coupon is a safe asset, and always payed 200 yen for each.

3 Results of Experiments

Our Results show that regret choice dependence is caused by regret aversion and scarcely occurs both in lottery choices and coupon choices.

3.1 Results of Experiment A

The results are in figure 1-4 and table 4-7.

The opportunity dependence was scarcely observed. In experiment A1, the weak axiom for rational choice strictly broken is found only in 2 subjects out of 46. However, five subjects change their best choice from < *a* > when lottery < *c* > is added, and 2 subjects changed their best choice to < *a* > not < *b* > when lottery < *c* > lost. These changes of choices show some kind of opportunity dependence because their attitudes toward risk changed by choice set. Subjects who were given choice set including < *c* > becomes more risk bearing.

When we compare with the result of experiment A2, the results of experiment A1 is not a disappointing result because no one breaks the weak axiom of condition IIA. These results also support our procedure because this results show the subjects selected one from their alternatives seriously.

group A No. of subject	treatment 1 choice from A1= (a,b)	treatment 3 choice from A1′= (a,b,c)	
1	a	c	become risky
2	a	c	become risky
3	b	b	
4	b	c	
5	b	c	
6	b	c	
7	a	c	become risky
8	b	c	
9	b	c	
10	a	a	
11	a	c	become risky
12	b	c	

Table 4: Result of experiment A1, group A, within subjects

group B No. of subject	treatment 1 choice from A1′ = (a,b,c)	treatment 3 choice from A1= (a,b)	
13	c	b	
14	c	b	
15	c	b	
16	c	b	
17	b	a	IIA broken
18	b	a	IIA broken
19	c	b	
20	c	b	
21	a	a	
22	a	a	
23	a	a	
23	c	b	

Table 5: Result of experiment A1, and B, within subjects

group C No. of subject	treatment 1 choice from B1= (d,f)	treatment 3 choice from B1′ = (d,e,f)	
24	d	d	
25	d	d	
26	e	e	
27	e	e	
28	d	d	
29	d	d	
30	d	d	
31	d	d	
32	e	e	
33	· d	d	
34	d	d	
35	d	d	
36	d	d	

Table 6: Result of experiment A2, group C, within subjects

group D No. of subject	treatment 1 choice from B1' = (d,e,f)	treatment 3 choice from B1= (d,e)
37	d	d
38	e	e
39	e	e
40	e	e
41	f	d
42	d	d
43	d	d
44	f	e
45	e	e
46	e	e
47	d	d

Table 7: Result of experiment A2, group C, within subjects

from A1= (a,b) choice	amount of answers in group A	A1' = (a,b,c) choice	amount of answers in group B
a	18	a	6
b	17	b	5
		c	24
ratio of a/b	1.06	ratio of a/b	1.20

Table 8: Result of experiment B2 between group A and B

from B1= (d,e) choice	amount of answers in group A	B1' = (d,e,f) choice	amount of answers in group B
d	21	d	18
e	15	e	13
—	—	f	5
ratio of d/e	1.40	ratio of d/e	1.38

Table 9: Result of experiment B2 between group C and D

We consider the reason why we cannot observe strong results that show choice dependence regret aversion as follows.

First, small reward without losing money when they include their participation reward makes them risk neutral. Next, rewards are decided in a probabilistic way, therefore subjects feel that the size of the rewards depends on fortune, not by their acts of lottery choices. In other words, when the opportunity set is perfectly objective, subjects cannot feel the reason of their action, therefore the act as a rational choice maker.

3.2 Results of Experiment B

In this subsection, we consider the meanings of results of experiment B.

From figure 2 and figure 3, we can find subject A9, A12 and B18 decrease their risk free asset and increase risky asset when they were restricted the amount of risky assets. The three subjects out of 23 subjects are not so large. However,when we consider that their choices are controlled to be serious with real money and without income effect, we can interpret this result as having some validity.

From figure 4 and figure 5, we can find subjects C27, C28, C29, C30, D42 increased their risk free assets when they were restricted to hold these.

The order of treatment may affect peoples' consistency because changes in their attitude toward risk is often observed when restriction is added in treatment 2. This fact is interesting when we consider the application to the financial market: the effect of relaxing constraint may be smaller than stressing constraint. Short sales constraint is said to be one of the reasons of equity premium because people who do not have stocks cannot sell them. However, the relaxing the constraint may not change peoples judgement largely. In contrast, the stressing restriction may affect peoples decision making in way of some kind of ex-post opportunity.

4 Concluding Remarks

The opportunity dependence is not broadly observed when they confront perfectly objective choice sets. However, some agents were induced to the braking condition of IIA, so the best choice in subset changed in the larger set when the added alternative
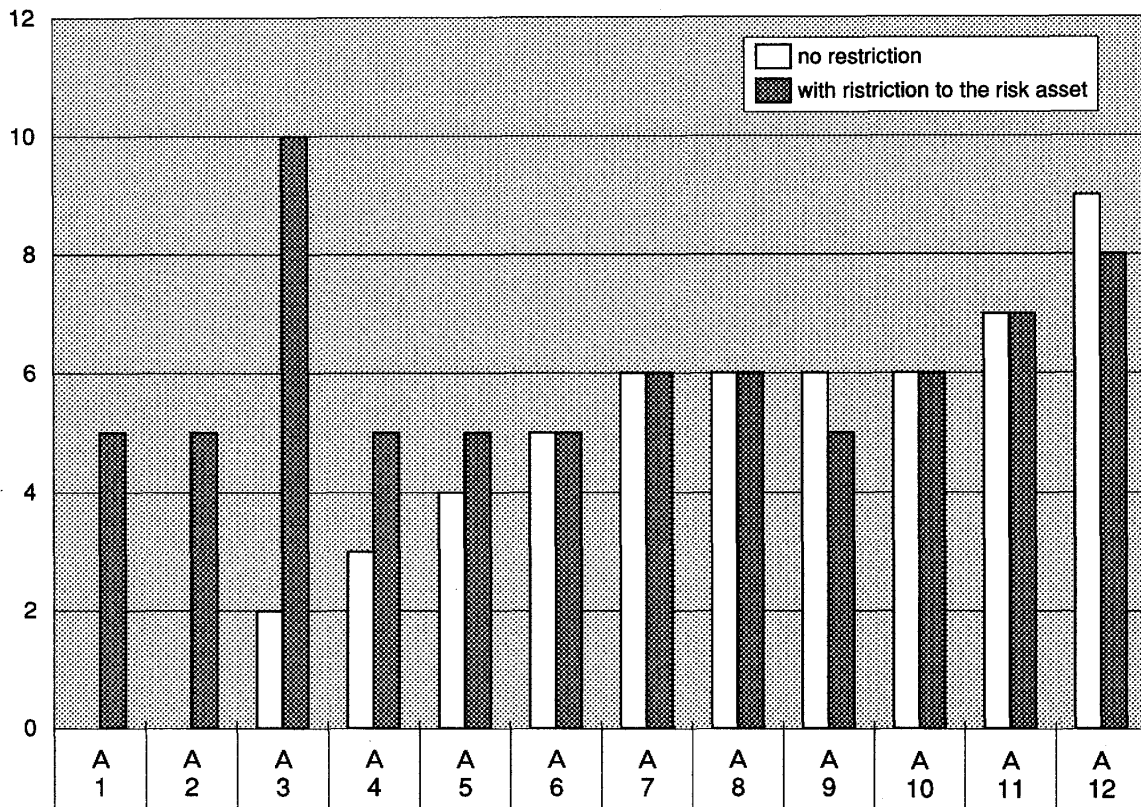
Figure 2: The amount of risk free asset group A selected, with restriction of risky asset
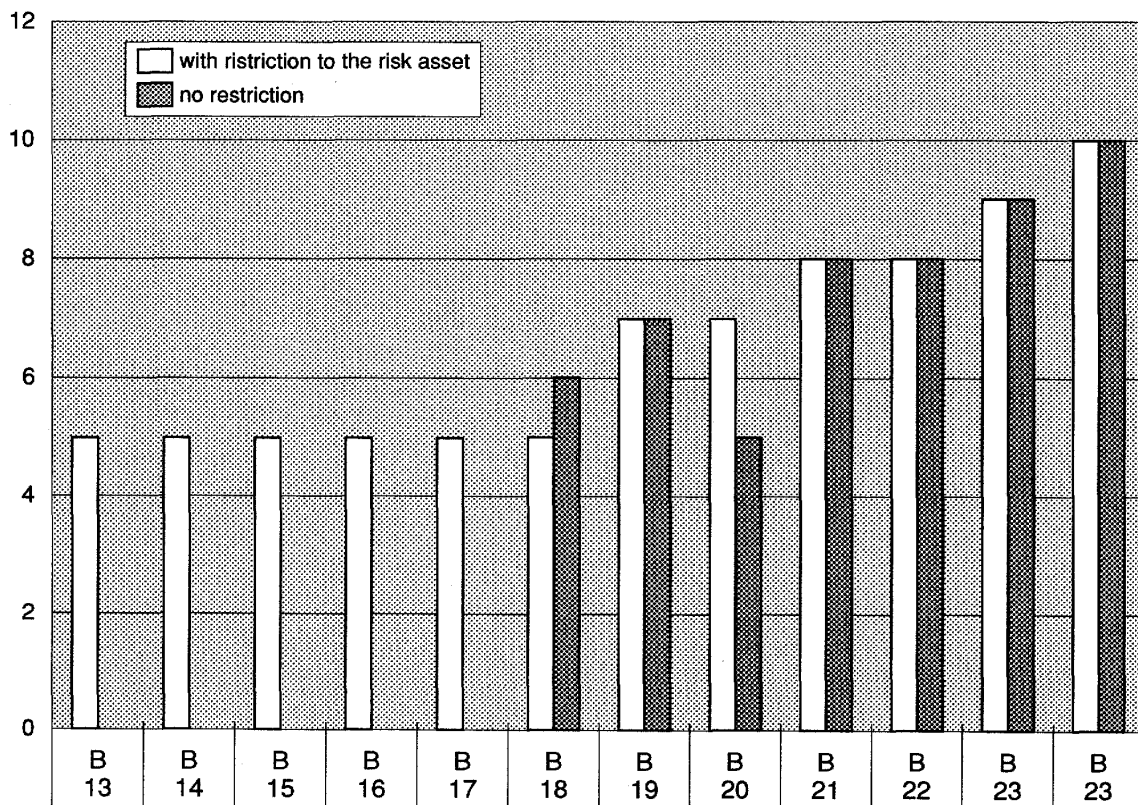

Figure 3: The amount of risk free asset group B selected, with restriction of risky asset
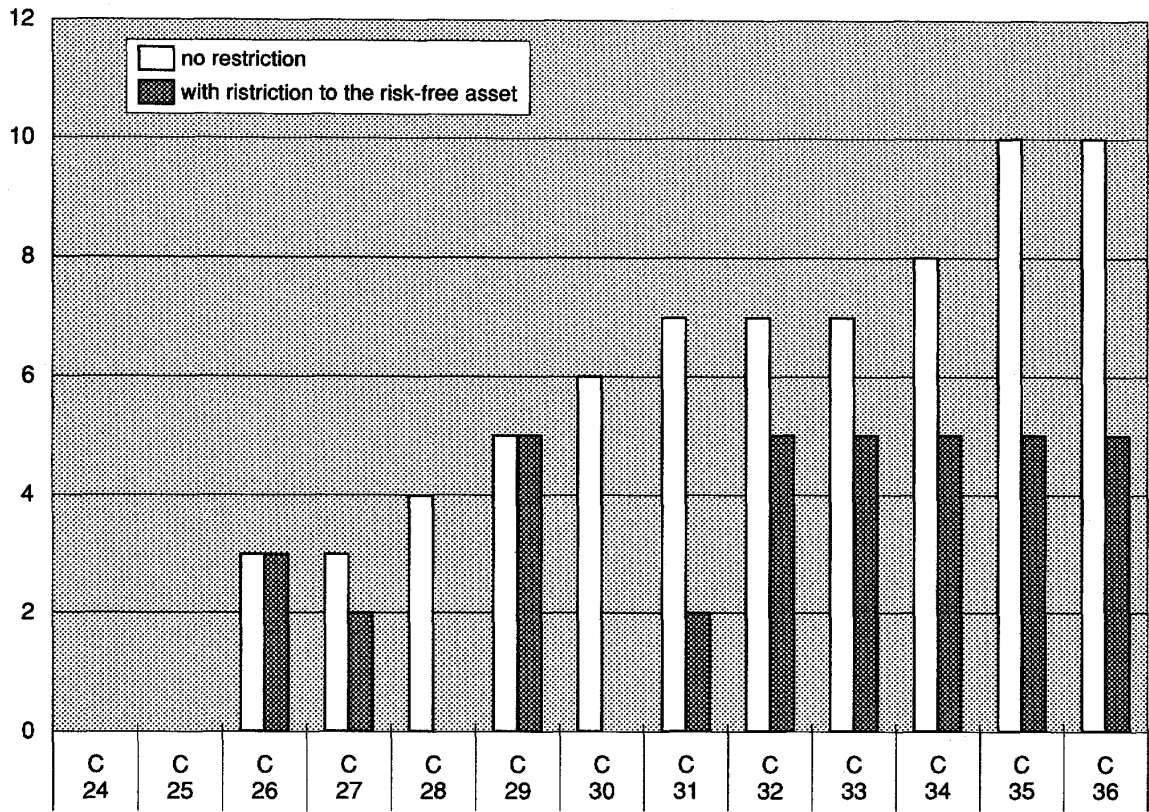
Figure 4: The amount of risk free asset group C selected, with restriction of risk Free asset
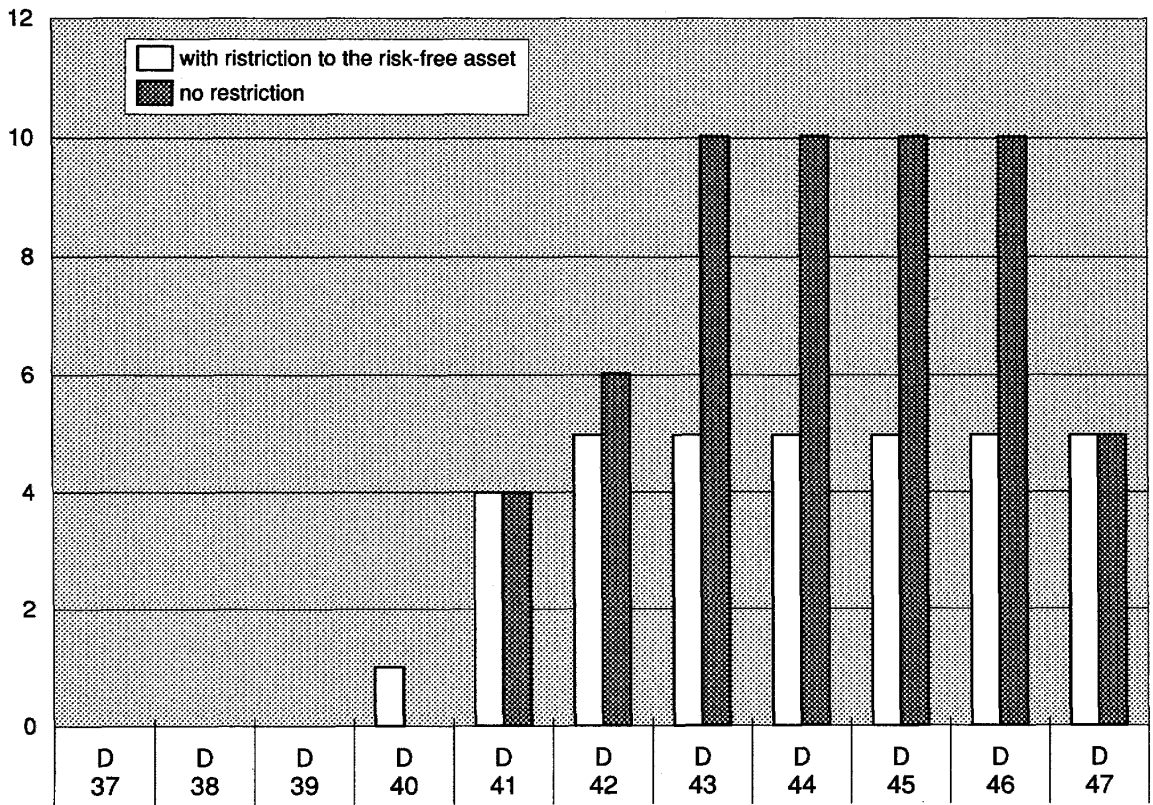

Figure 5: The amount of risk free asset group D selected, with restriction of risk free asset

changed the maximum regret of the set. We also find some people become more aggressive in risk attitude when they are restricted to have risky assets. In contrast, some people increase risk free assets when they are restricted to have those. However, making some constraint of asset choice does not matter strongly in portfolio selection. Most subjects keep their strategy.

We can conclude opportunity dependence caused by ex-post regret aversion occurred within minority.

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