When Integration Works Better than Segregation Does in Multiple-Gain Situations: The Revised Coding Rules in Mental Accounting

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Abstract--**Mental accounting based on the S-shape value function in prospect theory has been widely accepted since it was posited. The coding rules in mental accounting (CRMA) further suggest that segregating gains in multiple-gain situations and aggregating losses (to one big loss) in multiple-loss situations are preferred. CRMA have been then successfully applied to many fields. However, in our daily life, we can find occasions when people tend to aggregate gains in multiple-gain situations (accumulate small money from colleagues for a bigger wedding gift) or segregate losses in multiple-loss situations (phase a monthly donation amount to a smaller daily amount). The only study to date showing experiment results conflicting to CRMA, though, focuses on comparing the utility losses of two losses that happen on the same day and on different days. In this study, in order to resolve the inconsistency, we replicate Thaler's experiments with different dollar amounts used in both gain and loss scenarios and propose that mental threshold could be the major reason why in some situations CRMA may not be applicable. Our results show that in multiple-gain (or multiple-loss) situations, CRMA reverse when the accumulated gain (or loss) is over people's mental threshold while the individual gains (or losses) are not.**

Another finding is that in prior-gain or prior-loss situations, the original reference points can serve as a natural mental threshold. When the accumulated gain (or loss) of multiple gains (or losses) is over the original reference point (anchored by prior gains or losses) while the individual gains (or losses) are not, our experiment results show that people's preference on segregating gains and aggregating losses is reduced.

I. INTRODUCTION

In 1979, the well-known prospect theory [9] was proposed using value function to replace utility function used in tradition economic theory. Rather than the absolute values, the value function is defined over perceived gains and losses relative to some reference point. One of the important features of the value function is that its sensitivity diminishes on both gain and loss, which makes the value function S-shaped. In 1985, based on prospect theory, the coding rules in mental accounting (CRMA) suggesting that integration in multiple-gain situations and segregation in multiple-loss situations yield better psychological utility were proposed [16] and later on became a widely accepted theory and applied to many fields [1, 3, 7, 11, 15]. However, in our daily life, we found that CRMA might not be applicable in some occasions. Consider the following scenarios:

Example 1:

> John is going to get married. To give John a nice wedding gift, each colleague in John's department pays fifty dollars to accumulate one thousand dollars for a gorgeous necklace.

Example 2:

> A charitable organization promotes its donation program by breaking down the monthly donation amount to daily amount. For example, organizations may try to convince people to donate 15 dollars per month by using the following slogan: "50 cents a day can save a child from poverty".

The above scenarios can be easily seen in our daily life, but contradict to what CRMA would predict. We found that mental thresholds might have played a role in this contradiction. In multiple-gain situations, when the aggregated gain (one thousand dollars in example 1) exceeds the mental threshold point while each individual gain (fifty dollars in example 1) is relatively much smaller than the mental threshold, some extra utility is obtained which might help the utility gained from the aggregated gain (one thousand) exceed the accumulated utility gained from each individual gain and result in the contradiction. The same concept can apply to multiple-loss situations, too. In our first experiment, we use three sets of numbers (small, medium, larger) to redo what Thaler has done in 1985 [16]. The results shows while the questionnaires using the smaller and larger number sets get the results similar to Thaler's results, the medium one (obtained from a pretest which is used to locate the position of mental thresholds) gets the reverse results. This result supports the impact of mental threshold on utility evaluation.

Mental thresholds may vary in different conditions [4, 5]. One example from daily life is when getting a one-hundred-dollar discount, people may be happier if it is from purchasing a bicycle than a car. In our second experiment, we use the same scenarios used in our first experiment with the medium set of number (which produce results contradicting to CRMA), and modify it by adding a hypothetical condition to change the anchors/reference points. The result shows that the additional conditions do change people's preference back to what CRMA predict.

The ever varying nature of mental thresholds sometimes make people wonder if there is any mental threshold other than the origin that is generally applicable to people or situations. In this study, we propose that the original reference point in prior-gain or prior-loss situation could be a generic mental threshold. In fact, Thaler and Johnson's experimental results in their study [18] supports this proposal. In their experiments, both house money effect and break-even effect diminish when the sizes of the gamble approach to the

original reference point in both prior-gain (house money effect) and prior loss (break even effect) situations. In other words, the original reference point acts as a mental threshold which influence people's decision. In our third experiment, we add a prior-gain scenario in multiple-loss case and a prior-loss one in multiple-gain case. The result shows that the additional prior-gain and loss-scenario do influence the utility evaluation and reduce people's preference on segregating gains and integrating losses.

The rest of this paper is organized as follows: literatures are reviewed and hypotheses are proposed in section two; the experiment designs, results, and analysis are presented in section three; discussion is provided in section four; empirical implications and future works are shown in the last section.

II. LITERATURE REVIEW

A. Mental accounting coding rules and hedonic editing hypothesis

In 1985, Thaler [16] introduced the concept of mental accounting based on prospect theory [9]. In his study, he claimed that the way gains and losses are coded based on the following four rules:

1. Segregate multiple gains.
2. Integrate multiple losses.
3. Segregate small gains from larger losses (silver lining effect).
4. Integrate small losses with larger gains (cancellation effect).

Since then, these four coding rules in mental accounting (CRMA)[1] have been successfully applied to various fields [1, 3, 7, 11, 15]. In 1990, Thaler and Johnson proposed hedonic editing hypothesis which suggests that people tend to edit the outcome in a most pleasant way [18]. This hypothesis concludes that CRMA are the most pleasant way to edit the outcome and will be applied whenever possible for people. However, when they tried to apply it to temporal domain, some of the results in their study contradicts the prediction of CRMA. Specifically, when the respondents were asked if they prefer to have two gains or two losses on the same or different days, while they still prefer to segregate multiple gains (have two gains on different days), they tend to segregate (instead of integrating as CRMA predicts) multiple losses (have two losses on different days). In their revised hypothesis (which was called quasi hedonic editing because it follows hedonic editing hypothesis only part of time), after an initial loss, rather than risk seeking, it is risk aversion that prevails [18].

This is the first literature that explicitly showed the occasions that CRMA might not be applicable. However, it is arguable to claims the results shown in their study are the counter examples of CRMA. The main reason is that in their experimental scenarios, no matter the losses happen on the same day or not, they are still treated as two separate losses by decision makers since the losses are presented as two separate identities. In other words, the integration and segregation are related to time, not to gains or losses. For this reason, quasi-hedonic editing hypothesis can only be treated as a temporal version of CRMA and cannot be viewed as a counter example of it.

There are some other studies related to mental accounting or hedonic editing hypothesis. Linville and Fischer extended Thaler and Johnson's research from quantitative financial events to qualitative academic or social events and offered more explanation on the mental mechanism of hedonic editing hypothesis [11]. Slattery and Ganster reexamined and supported quasi-hedonic editing hypothesis in a dynamic uncertain decision environment [15]. Cowley applied hedonic editing hypothesis to retrospective evaluation and tested it in gambling context, and found that potentially irresponsible gamblers tend to edit past experience to a more positive way [3]. These studies had shown that hedonic editing hypothesis could not be applicable in some particular occasions. However, they were also restricted to temporal related context and the related explanation can't be applied to the temporal unrelated scenarios.

In summary, so far there is no prior literature that shows any result contradicting to what CRMA predict in temporal unrelated scenarios. In other words, nobody had challenged that segregation could be better than integration in multiple-gain situations, or integration could be better than segregation in multiple-loss situations.

B. Threshold based utility model for temporal unrelated events

The value function proposed in prospect theory has been widely used without any challenge [9]. One of the most important characters of the value function is that it is concave in gains and convex in losses. In other words, the sensitivity diminishes in both gain and loss segments. However, as shown in introduction, the value function alone can't explain some empirical observations. It gives us a strong motivation to seek other factors that might impact decision making process, and generalize the value function to cover these cases.

In this study, we would like to add the concept of thresholds to the S-shaped value function proposed in prospect theory [9]. In prospect theory, origin plays an important role in S-shaped value function in that the sensitivity starts diminishing toward both ends. Indeed, in many situations, the result of winning and losing means different in a dramatic way to most of people. This dramatic change on the result happens to be the most important character of thresholds. Threshold in psychology means that the points where small magnitude changes can cause much larger difference in result than other points. In this sense, from the standpoint of thresholds, origin can be treated as a threshold in value function. Since there could be more than

[1] In this study, we focus on the first two rules only, but still use CRMA as the term to describe these two rules.

one threshold in some psychological and physical effects, we would assume that it is the same for decision making. In other words, we would propose that in a multiple-gain or multiple-loss scenario, the sensitivity sometimes can be magnified at more than one point, as oppose to only one (origin) proposed in prospect theory. If we follow the denotation of Thaler's work [16], for a value function $v(\bullet)$, other than origin ($x = 0$), there could be one or more t such that in a range $[m, n]$, $m < t < n$, we have $v''(x) < 0$, $n > x > t$; $v''(x) > 0$, $m < x < t$. We call these points as *thresholds*. In this revised value function, when there is a threshold, there is an S-shape curve corresponding to it with the threshold as the inflection point. Notice that the original value function can be treated as a special case of this generalized value function. Fig. 1 illustrates the revised function with multiple thresholds.

The concept of thresholds has been widely used in price sensitivity [5, 8, 10, 14], advertising promotion [4], biophysical chemistry [12, 13], and many other fields. There are two important characters often shared by threshold based models:

1. The corresponding function is formed by S-shaped curve(s). [4, 8]
2. The thresholds are different in different situation.[4, 5]

The first character of thresholds fits perfectly to the value function of CRMA since it was originally proposed as a S-shaped function [16]. Our proposed utility model just extends the original utility model to be one or more than one threshold(s) depending on situations. The revised value function is therefore formed by one or more than one S-shaped curve(s). The extra S-shaped curves can help us why the utility of the integrated gain can be larger than the sum of the utilities from individual gains in multiple-gain situations. This concept is illustrated in Fig. 2. This revised utility model can be used to explain those two scenarios described in the previous section. Based on the revised value function, we would like to extend CRMA and propose:

H1: People may prefer to aggregate gains and segregate losses when the accumulated gain or loss exceeds a mental threshold.

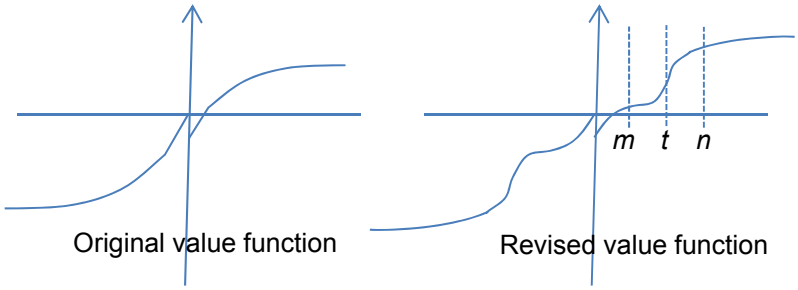


Fig. 1. Original value function and revised value function

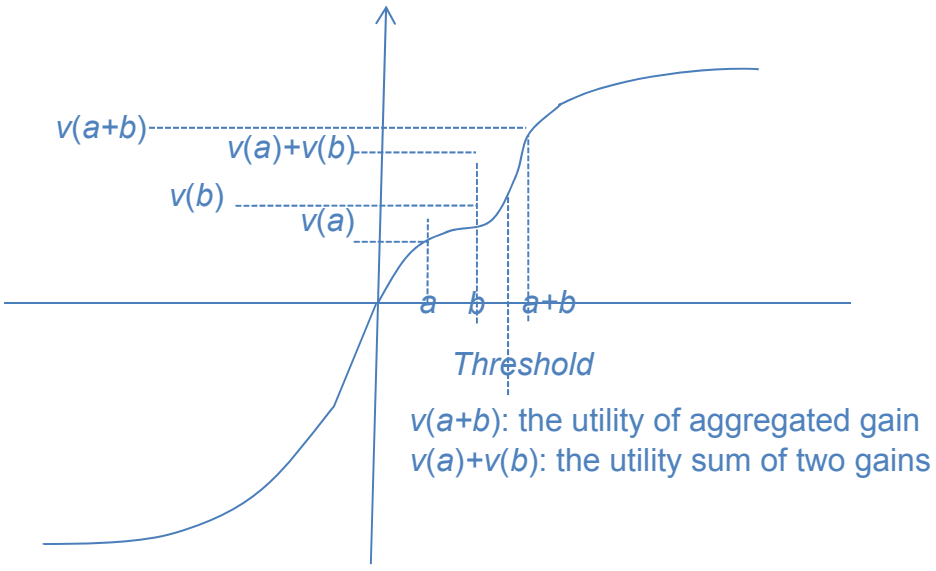


Fig. 2. Integration in gains may generate higher utility than segregation in a multiple-gain situation when the combined gain exceeds a threshold

Jarnebrant, Toubia, and Johnson's research [6] offers a situation that contradicts the third rule (silver lining effect) of CRMA. In their study, concept of threshold is also used. They found that in a situation with the combination of big loss and small gain, aggregation could be better (which contradicts silver lining effect) when the gain is larger than a threshold. However, their study focuses only on silver lining effect, and most importantly the cause of thresholds is quite different from mental thresholds proposed in our study. Therefore we leave the detail of this literature's review in appendix.

The second character of thresholds is very common in various threshold-based fields. For example, the promotion thresholds are different across products and brands [4], and the price sensitivity thresholds are modeled as a function of company, competitor, and consumer specific factors [5]. In the original utility model, there is only one common threshold at origin. It is perhaps the most explicit and common threshold in all situations. In our proposed utility model, besides origin, there might be other thresholds which could be at different positions depending on situations. In other words, when situations are changed, the position of thresholds could also be changed which may result in the change of preference in multiple-gain or multiple loss situations. Based on this concept, we would like to propose:

H2a: In multiple-gain situations, people's preference on aggregating or segregating gains may be different even the size of gains is the same.

H2b: In multiple-loss situations, people's preference on aggregating or segregating losses may be different even the size of losses is the same.

C. Threshold based utility model in prior-gain and prior-loss situations

It's very common that people make decisions with the influence of prior gains or losses [9, 18]. As described in subsection 2.1, a few studies have discussed the preference of two gains or two losses happening on the same day or different time days under prior-gain or prior-loss conditions [2, 18]. In this study, we focus on multiple-gains and multiple-loss situations in prior-gain or prior-loss conditions. In other words, here we are interested in the changes of the value function after prior gains or losses.

A value function in prospect theory with prior gains or losses should still contain all the characters owned by the one without prior gains or losses. However, the original value function obviously can't explain why house money effect and break-even effect diminish as the size of total losses or gains reach the initial stake (original reference point). House money effect ascertains that after a prior gain, the utility loss of the subsequent loss is smaller than the one in the same situation without a prior gain. The reduction of utility loss facilitates the tendency of risk seeking. But this tendency may reduce as the size of subsequent losses approaches the initial stack [18]. Break-even effect is similar to house money effect except it happens in a prior-loss situation with potential gains. Both effects can't be explained by a simple S-shaped utility function. On the other hand, they can be explained by treating the original reference point as a threshold. Taking a prior-gain scenario as an example, because the original reference point act as a threshold, the utility loss drops dramatically as the size of the loss approaches to the original reference point, which makes house money effect diminish. Similar explanation can also be applied to break-even effect. Since the original reference point can serve as a threshold, from coding rules' standpoint, people's preference on aggregating gains may increase when the aggregated gain exceeds the prior loss. Similarly, people's preference on aggregating losses may reduce when the aggregated loss exceeds the prior gain. Therefore, we would propose:

H3a: People's preference on segregating gains may be reduced by the addition of a prior-loss condition.

H3b: People's tendency on aggregating losses may be reduced by the addition of a prior-gain condition.

Fig. 3 illustrates the concept of H3. H3 provides an operable way to find a mental threshold for researchers to verify the existence of it.

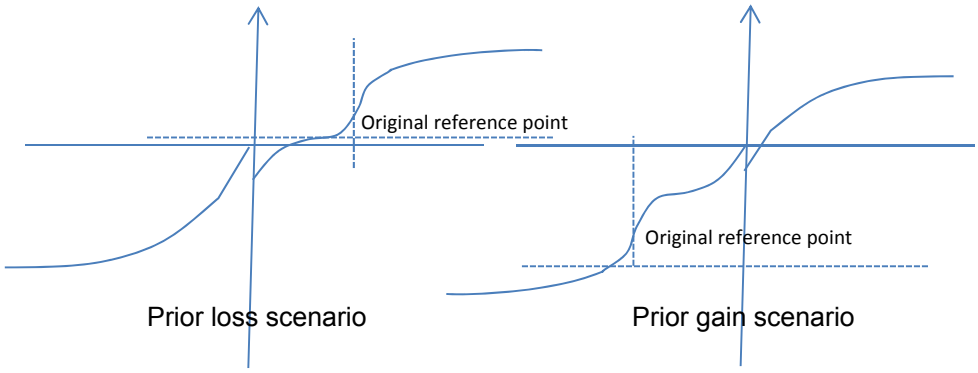


Fig. 3. Illustration of revised value functions in prior-gain and prior-loss situations

From the standpoint of value function, it is even easier to know that there is another reflection point other than the original point in prior-gain or prior-loss situations from a prior literature. In Thaler and Johnson's study [18], the experiment showed that after a 15-dollar prior-gain, 77% respondents chose to join a gamble for 50% of winning 4.5 dollars and 50% of losing 4.5 dollars. This means that the curve of the value function is less steep on the negative side than the positive side before the size of gamble reaches the original reference point (-15 dollars in this case). However, in the other experiment, 64% respondents chose not to join a game for 50% of winning 9 dollars and 50% of losing it after a 9-dollar prior-gain. This means when the size of gamble reaches the original reference point (-9 dollars in this case), the curve of the value function on the negative side has become steeper than the positive side. It is not possible on a smooth curve unless there is a reflection point. Fig. 4 illustrates this concept.

III. EXPERIMENTS

The experiments are done by giving questionnaires to college and graduate students in a college located in Hsinchu, Taiwan. The respondents are found in convenient stores or cafeterias. Our questionnaires are consisted of two pages: the first page contains two scenarios – one is multiple-gain scenario and the other is multiple-loss one; the second page contains some personal information such as gender, age, profession, educational background, etc.

Different sets of number denoted by (*X*, *Y*, *Z*) are applied to the scenarios for comparison. Using (200, 100, 300) as an example, the multiple-gain scenario is as follows:

Mr. A was given a few tickets to lottery involving World Series by friends. As a result, he won *200* NTD from one lottery ticket and *100* NTD from the other.

Mr. B was given a few tickets to lottery involving World Series by friends. As a result, he won *300* NTD from one lottery ticket.

Who was happier? A _____ B _____ No difference _____

The multiple-losses scenario is as follows:

Mr. A received two letters from IRS: one said that he has to pay additional *200* NTD for his income tax and the other said that he has to pay *100* NTD for his property tax.

Mr. B received a letter from IRS saying that he has to pay additional *300* NTD for his income tax.

Who was more upset? A ____ B ___ No difference _____

Notice that *X* plus *Y* equals *Z* so the total size of gain and loss for Mr. *A* and Mr. *B* are the same. These two scenarios are almost identical to Thaler's questions in his mental accounting study [16].

There are three experiments in this study. The first experiment redo what Thaler has done in 1985 [16] using three number sets. These number sets are selected based on the result of a pretest which is used to detect the mental threshold of respondents. The second experiment is similar to the first one except that one extra condition is added to each of the multiple-gain and multiple-loss questions. The third experiment is also similar to the first one except that a prior-loss condition is added to the multiple-gain scenario and a prior-gain condition is added to the multiple-loss scenario.

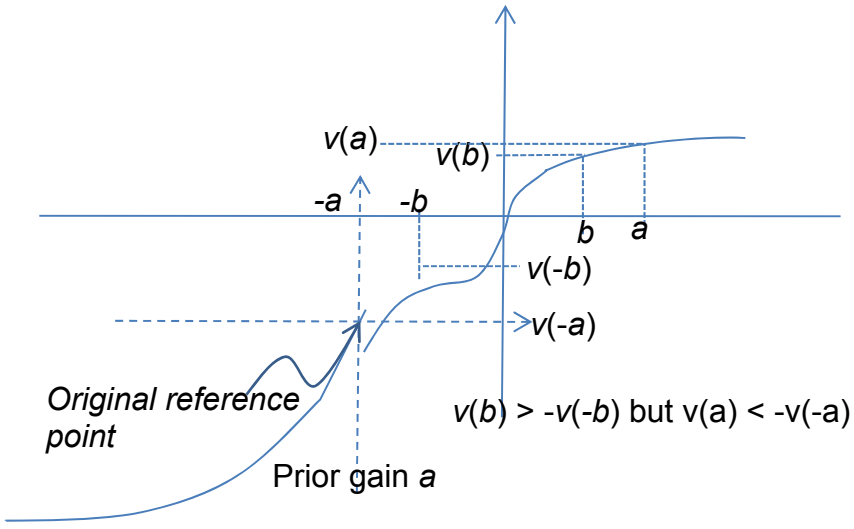


Fig. 4. Illustration of the existence of reflection point around original reference point in a prior-gain situation from the inference of Thaler and Johnson's experiments

A. Experiment 1

1. Method

To verify the mental thresholds of the two test cases, we do a pretest to decide the number sets that we will use for this test. The gain scenario used in pretest is as follows:

> You are given a few tickets to lottery involving World Series by friends. As a result, you win *X* NTD from one lottery ticket. How much is *X* will start making you particularly happy?

The loss scenario used in pretest is as follows:

> You receive a letter from IRS saying that you have to pay additional *X* NTD for you income tax. How much is *X* will start making you particularly upset?

A list of numbers: "less than 300 NTD", "300 NTD", "600 NTD", "900 NTD", ..., "3600 NTD", "more than 3600 NTD" (The currency ratio between NTD and USD is around 1:30) is provided to respondents to choose. The result illustrated in Fig. 5 shows that NTD 1200 might have a mental threshold around it.

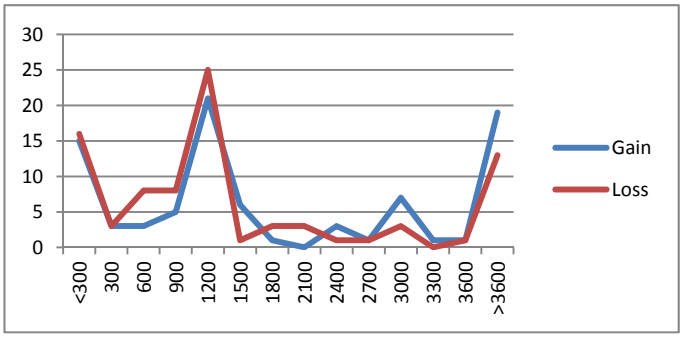


Fig. 5: The result of mental threshold pretest

We then decide to use (200, 100, 300), (800, 400, 1200), and (1200, 600, 1800) as the three sets for the experiment. The first and three sets are used to avoid the issue that the result might be caused by the size of the number set. The ratio of *X*, *Y*, and *Z* is 2: 1: 3. This ratio was used in Thaler's experiments [16] so we adopt it to make our experiment as close as Thaler's one as possible. 85, 129, and 50 valid questionnaires were collected for (200, 100, 300), (800, 400, 1200), and (1200, 600, 1800).

2. Result

The results are shown on table 1. Reverse orders for the presentation of Mr. A and Mr. B, segregated gains/losses and aggregated gains/losses, and *X* and *Y* (e.g., change the order of 200, 100 to 100, 200 in the set of 200, 100, and 300) in the questionnaires are tested and show no statistical difference to the result.

It can be seen in Fig. 6 that while the results of using (200, 100, 300) and (1200, 600, 1800) consistent with CRMA, while the result of using (800, 400, 1200) shows otherwise. This result supports H1.

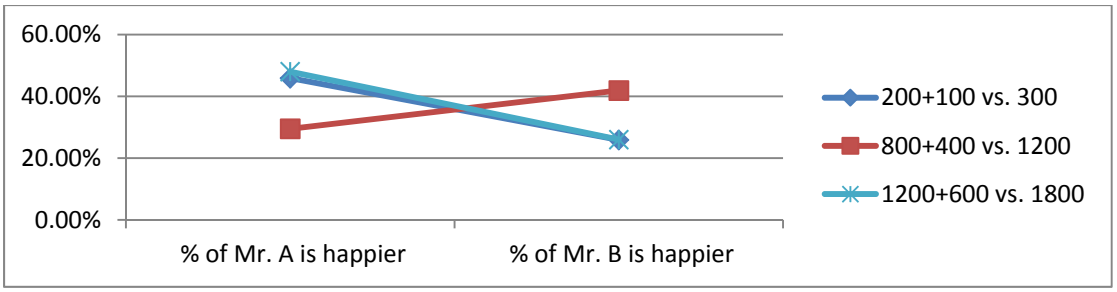
B. Experiment 2

1. Method

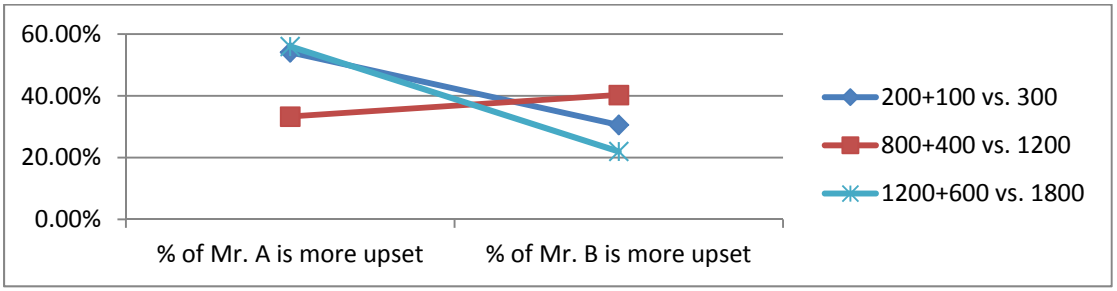
This experiment examines if an additional condition that changes people's reference points would also change people's preferences on segregating gains and aggregating losses. In this experiment, scenarios similar to the ones used in experiment 1 are provided. A condition is added to each scenario to make the number(s) in the original scenarios look smaller. Because it is easier to change a threshold than generate one by changing people's reference points, we use (800, 400, 1200) as the number set for the questionnaire used in this experiment. 50 valid questionnaires for scenarios with framing description were collected to compare to the result of 85 valid questionnaires for scenarios without framing (done in Experiment 1). The scenarios used in this experiment are as follows:

TABLE 1. THE RESULT OF EXPERIMENT 1

Gains	Mr. A is happier	Mr. B is happier	No Difference
200+100 vs. 300	39	22	24
800+400 vs. 1200	38	54	37
1200+600 vs. 1800	28	11	11
Loss	Mr. A is more upset	Mr. B is more upset	No Difference
200+100 vs. 300	46	26	13
800+400 vs. 1200	43	52	34
1200+600 vs. 1800	24	13	13
Gains	% of Mr. A is happier	% of Mr. B is happier	% of No Difference
200+100 vs. 300	46%	26%	28%
800+400 vs. 1200	29%	42%	29%
1200+600 vs. 1800	48%	26%	26%
Loss	% of Mr. A is more upset	% of Mr. B is more upset	% of No Difference
200+100 vs. 300	54%	31%	15%
800+400 vs. 1200	33%	40%	26%
1200+600 vs. 1800	56%	22%	22%



(a) Multiple-gain scenario



(b) Multiple-loss scenario

Fig. 6. Illustration of the result of Experiment 1

The multiple-gain question:

Friends gave Mr. A a few tickets to lottery *involving company's year-end party. The prizes for the lottery range from 100 to 50,000*. As a result, he won *800* NTD from one lottery ticket and *400* NTD from the other.

Friends gave Mr. B a few tickets to lottery *involving company's year-end party. The prizes for the lottery range from 100 to 50,000*. As a result, he won *1200* NTD from one lottery ticket.

Who was happier? A _____ B ____ No difference _____

The multiple-loss question:

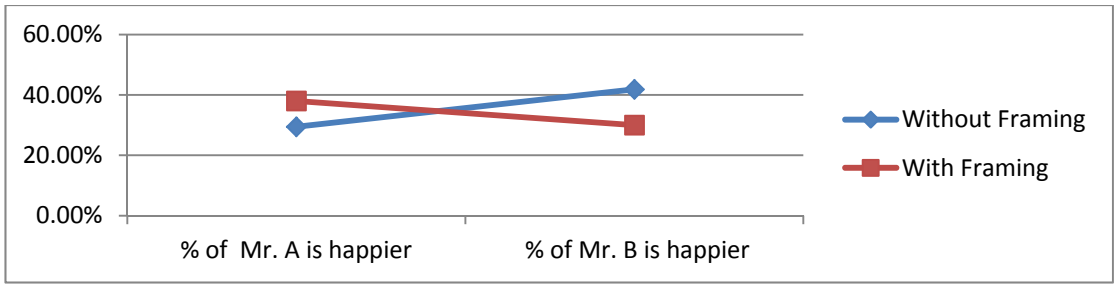
Mr. A received two letters from IRS *after paying 200,000 NTD tax*: one said that he has to pay additional *800* NTD for his income tax and the other said that he has to pay *400* NTD for his property tax.

Mr. B received a letter from IRS *after paying 200,000 NTD tax* saying that he has to pay additional *1,200* NTD for his income tax.

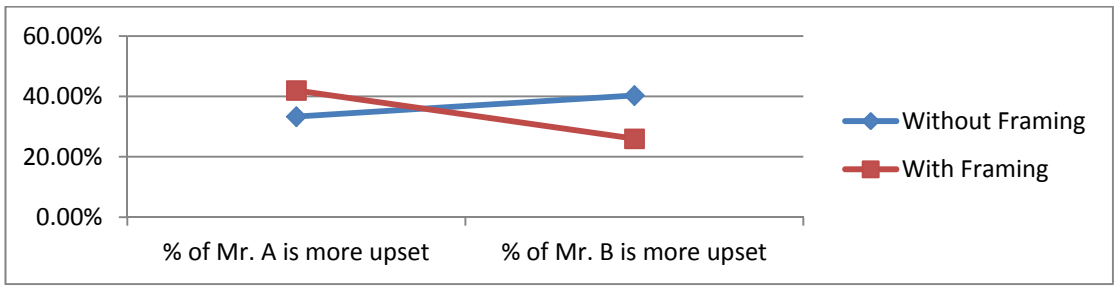
Who was more upset? A ____ B ___ No difference _____

TABLE 2. THE RESULT OF EXPERIMENT 2 (COMPARING TO EXPERIMENT 1)

Gains	Mr. A is happier	Mr. B is happier	No Difference
Without Framing	38	54	37
With Framing	19	15	16
Loss	Mr. A is more upset	Mr. B is more upset	No Difference
Without Framing	43	52	34
With Framing	21	13	16
Gains	% of Mr. A is happier	% of Mr. B is happier	% of No Difference
Without Framing	29%	42%	29%
With Framing	38%	30%	32%
Loss	% of Mr. A is more upset	% of Mr. B is more upset	% of No Difference
Without Framing	33%	40%	26%
With Framing	42%	26%	32%



(a) Multiple-gain scenario



(b) Multiple-loss scenario

Fig. 7. Illustration of the result of Experiment 2 comparing to Experiment 1

2. Result

The result of Experiment 2 is shown on Table 2 and illustrated in Fig. 7. It is compared with the result of Experiment 1 using (800, 400, 1200). It can be seen that people's preferences are changed back to aggregate gains and segregate losses are changed by the additional conditions. This result supports H2.

3. Analysis

The experimental result supports the hypothesis that thresholds for people are not absolute numbers. They are relative to situations. The similar concept is actually offered in Thaler and Johnson's research published in 1990 [18]. In the experiment 3 of their study, they found that the loss of $9 after a $36 loss is more painful to the respondents comparing to the same loss after a $9 loss, but less painful after a $1000 loss than after a $30 loss. Their tentative explanation is that a larger loss may numb the individual to further small losses. They also added a remark saying that a large prior-loss produces a contract effect that makes the subsequent loss looks smaller. In Thaler's experiment, the $1000 prior-loss changes people's reference point and make the consequent $9 loss look smaller, just like the 200,000 NTD tax payment makes the following 1200 NTD loss look smaller in our experiment. Thus the threshold around it no longer exists and the result reverses again and follows CRMA's prediction.

C. Experiment 3

1. Method

This experiment is used to verify the influence of prior gains/losses. In this experiment, we use a questionnaire similar to what we use in experiment 1, too. The only differences on the scenarios are a prior-loss condition is added to the multiple-gain scenario and a prior-gain condition to multiple-loss scenario in the questionnaire. Because the size of prior gains/losses could be different, one additional variable *M* is added to the number set for the prior gain/loss. So the number set used in this experiment is denoted by (*M*: *X*, *Y*, *Z*). The scenarios in the questionnaire are as follows:

The multiple-gain scenario with a prior-loss condition:

> Mr. A just paid additional *M* NTD for miscalculating tax. Later on he was given a few tickets to lottery involving World Series by friends. As a result, he won *X* NTD in one lottery ticket and *Y* NTD in the other.
>
> Mr. B just paid additional *M* NTD for miscalculating tax. Later on he was given a few tickets to lottery involving World Series by friends. As a result, he won *Z* NTD in one lottery.
>
> Who was happier? A ____ B ___ No difference _____

The multiple-loss scenario with prior-gain condition:

> Mr. A just won an *M* NTD lottery ticket given by a friend. Recently he received two letters from IRS: one said that he has to pay additional *X* NTD for his income tax and the other said that he has to pay *Y* NTD for his property tax.
>
> Mr. B just won an *M* NTD lottery ticket given by a friend. Recently he received a letter from IRS saying that he has to pay additional *Z* NTD for his income tax.
>
> Who was more upset? A ____ B ___ No difference _____

(280: 200, 100, 300) is used in this experiment. The results of (200, 100, 300) obtained in experiment 1 is also shown for comparison. Notice that the numbers for *M* is a little less than *Z*. This is to enhance the influence of prior gains/losses. In our pretest, we find that the effect of prior gains or losses is not as

strong as when "300" instead of "280" is used for *M*. The feedback from the interviews is that the change from "gain" to "no gain" is somewhat less sensitive comparing to the change from "gain" to "loss", especially in a low involvement situation. Thus "280" instead of "300" is used for *M* to enhance the effect of prior gain and loss. 33 valid questionnaires were collected for prior-gain scenario in this experiment.

2. Result

The result of Experiment 3 is shown on Table 3 and illustrated in Fig. 8. Comparing to the result of (300, 200, 100), it can be seen that people's preference on segregating gains and aggregating losses is reduced by the addition of a prior-gain or prior-loss scenario. This result supports H3.

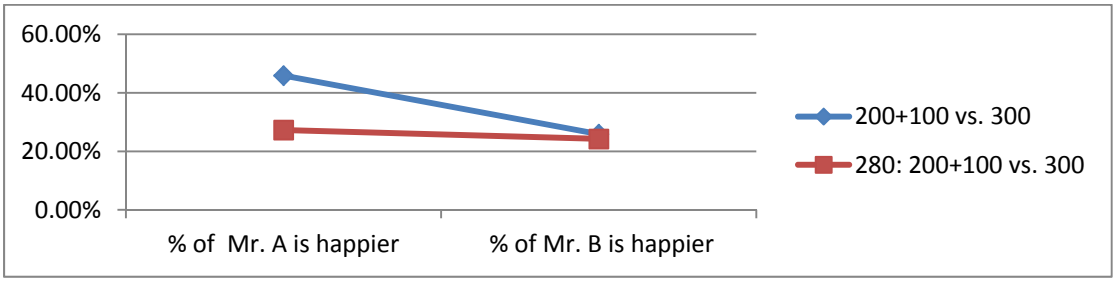
3. Analysis

The result of (280: 200, 100, 300) is not as compelling as the result of (800, 400, 1200) that reverses CRMA's prediction. The explanations could be:

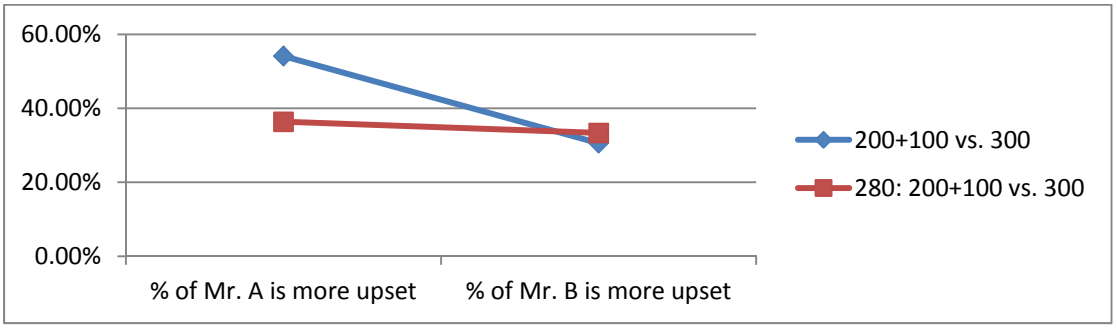
1. The size of either prior-gain or prior-loss ("280" in this experiment) is relatively less sensitive to the respondents. Therefore the effect generated by prior gain and loss is not powerful enough to overcome the effect of prospect theory.

TABLE 3. THE RESULT OF EXPERIMENT 3 (COMPARING TO EXPERIMENT 1)

Gains	Mr. A is happier	Mr. B is happier	No Difference
200+100 vs. 300	39	22	24
280: 200+100 vs. 300	9	8	16
Loss	Mr. A is more upset	Mr. B is more upset	No Difference
200+100 vs. 300	46	26	13
280: 200+100 vs. 300	12	11	10
Gains	% of Mr. A is happier	% of Mr. B is happier	% of No Difference
200+100 vs. 300	46%	26%	28%
280: 200+100 vs. 300	27%	24%	49%
Loss	% of Mr. A is more upset	% of Mr. B is more upset	% of No Difference
200+100 vs. 300	54%	31%	15%
280: 200+100 vs. 300	36%	33%	30%



(a) Multiple-gain scenario



(b) Multiple-loss scenario

Fig. 8. Illustration of the result of Experiment 3 comparing to Experiment 1

2. The prior gain and loss conditions are less sensitive to the respondents: the tax is what Mr. A/B ought to pay, and the lottery ticket is given by a friend. It makes the impact of the recovery of prior gain/loss less attractive.
3. After showing the prior gain/loss, people move their focus to the comparison between prior gain/loss and the following total losses/gains and care less about if the gains and losses are integrated or segregated. This might be the reason why the preference of integration and segregation are close to each other in both scenarios.

The result also shows while the percentage of choosing both integrated gains and integrated losses in a prior-loss or prior-gain situation is close to the one not in a prior loss or gain situation, the percentage of choosing both segregated gains and segregated losses in a prior-loss or prior-gain situation is much smaller than the one not in a prior-loss or prior-gain situation. This is an open question and one of the good topics for future study.

IV. DISCUSSION

The results which are shown in the previous section support our hypotheses. The result of experiment one has shown that people's preference on segregating gains and aggregating losses may reverse and the size of gains or losses is unlikely the reason. The result of experiment two has shown that even the size of gains or losses are the same, people's preference on aggregating or segregating gains/losses may still be change in different situation. The result of experiment three has shown that such a preference may be reduced by a prior gain or prior loss condition. These results provide experimental evidence to support our threshold based utility module. In the rest of this section, we would like to offer more theoretical discussion about how people make decisions in multiple-gain and multiple-loss situations.

When the total size of gain or loss is the same, there are a few aspects in a scenario that could potentially influence people's decisions. The first one is the number of gains or losses in the scenarios. From prospect theory we know people would follow CRMA which can be explained by S-shaped value function. Here we offer a simplified version: when the total size of gains or losses is the same or less concerned, people make decisions by the number of gains or losses. By all means, the more number of gains and less number of losses the better. This simple and intuitive rule can also derive to the same conclusion as CRMA. The second aspect is the size of gain or loss in aggregated situations and each gain or loss in segregated situations (we use "size" to simplify the description in the following description). When size is less important, the number of gains or losses dominates decisions and CRMA prevails. However, it is not always the case. Our experiments have shown that size does matter in some situations. Mental thresholds offer a good explanation about why it does. In multiple-gain and multiple-loss situations, prospect theory's conclusion emphasizes that the number of gains/losses dominates people's decision, and our study adds that size sometimes is also a factor. It is interesting to see if there is any new aspect influencing people's decisions in multiple-gain and multiple-loss situations can be found in the future.

The utility of each individual gains or losses are also decided by a few factors. From the experiments that we have done in the previous section, it is at least influenced by the following two factors:

1. The size of gain/loss.
2. People's reference points.

As proposed in our study, the relationship between the size of gain/loss and its utility is curve composed by one or more S-shaped curves which is influenced by mental thresholds. Changing people's reference points can be treated as a way to change people's mental thresholds, and the scenarios of prior gains or losses can be treated as a way of changing people's reference points. Here we would like to add one more factor: involvement. The main scenarios used in the questionnaires, as mentioned before, are based on what Thaler has done in his mental accounting research [16]. It should be noticed that the scenarios are somehow "detached" to the respondents: Mr. A and Mr. B are used in the questionnaire instead of using "I" or "You"; the lottery tickets are given by friends instead of bought by Mr. A or Mr. B; the tax fees that they have to pay are what they ought to pay instead of some extra losses (for example, penalty for filing the wrong number of tax). When the size of gains or losses is less concerned (the involvement is low), the number of gains or losses dominates people's decisions. However, in our daily life, people could be more sensitive to the total size of gains or losses. For example, in gambles or stock trading, people might be more exciting on a big win instead of a few small wins. Scenarios with different levels of involvement would be a good topic for the future study.

The next topic that we would like to discuss is a prediction derived from the single S-shaped value function in prospect theory: when the size of total gain is the same as the size of each individual gain is the same, more number of individual gains results in more total utility gain. Sometimes it is against some daily common sense as the charity promotion example is offered in the introduction section in our study. More experiments can be done for this topic. If the result shows that when the size of total size of gain is the same, more number of individual gains does not lead to more total utility gains, it would also be evidence that the value function for multiple-gains and multiple-loss situations is hardly just a simple S-shaped curve.

The prior-gain and prior-loss scenarios offer other examples that prospect theory has room to be revised: house money effect shows after prior gains the intention of gamble is higher than 50% when the site of gamble is smaller than the size of prior gains. This means that the utility of winning (or gaining) is higher than the utility of losing in such a

scenario, which contradicts what prospect theory states. So the generalized version of prospect theory could be: The utility function of prospect theory is formed by a few connected S-shaped curves and sometimes the curve on the loss side is not steeper than the one on the gain side, although it normally is.

In summary, from some daily scenarios and our experiment results, it is shown that CRMA might not be always right and the value function can't be a simple S-shaped curve. On the other hands, our threshold based revision offers an explanation to the situations that prospect theory can't explain. Although a complete version of value function could include much more factors that we haven't discussed in this study, we would like to provide a start for this interesting topic and look forward to seeing more scholars contribute to make people's decision more predictable.

V. EMPIRICAL IMPLICATIONS AND FUTURE STUDIES

In this study, prospect theory is extended from one S-shaped curve to a curve constructed by one or more S-shaped curves. Each reflection point in the S-shaped curve can be treated as a threshold. Because of the possibility of multiple thresholds, segregation might not be always better than aggregation in multiple-gain situations, and aggregation is not always better than segregation in multiple-loss situations. This extension can be used to explain some daily scenarios that can't be explained by the original prospect theory. The original reference point in prior gain or loss situation can also be treated as a threshold, which is also supported by the result of Thaler and Johnson's study in 1999 [17]. This extension can also help to explain house money effect and break even effect.

The conclusions of our study contain a few useful empirical implications. The first and most obvious one is that segregating gains or aggregating losses does not always lead to a better result. This is perhaps why lotteries normally emphasize the size of the biggest prize instead of how many prizes it has, and the insurance companies always show you how much you will pay for a day instead of total amount that you have to pay.

Another implication is on setting the price for set products. For example, the price for a set meal should not exceed your target customer group's mental threshold. Otherwise the integrated utility loss (the price for a set meal) could be higher than the sum of the individual utility loss (the price for each meal), which makes people less willing to buy.

The same concept can also be applied to technology management. For example, when developing new features for notebooks, smart phones or tablets, instead of diversifying resource for a few small features, aggregating resource for a big feature might be more impressive. Similarly, very often online stores offer discounts for additional purchases on the check-out webpage. Based on the results of this study, they should be careful about the price of the goods advertising on the check-out webpage. Customers will be less willing to make additional purchases if the total costs exceed their mental thresholds. Prospect theory is a useful theory in technology management. This extension can help managers in resource arrangement, online pricing and promotion strategy, product development strategy, etc.

There are a few topics worth for more future works. The following three are a few of them:

1. The impact of involvement: We predict that higher involvement will result in less effectiveness of prospect theory so that people are less sensitive on the difference between integration and segregation on multiple gains or losses.
2. Changing reference points: We have shown that the effect of a threshold can be reduced or eliminated by adding a scenario to change people's reference points. It would be interesting to see how a threshold can be formed by a scenario other than prior gains or losses.
3. Different size of gains/losses and different group of people: This study uses students as the respondents for questionnaires. It would be interesting to see how professional people with different level of incomes react to some real gains/losses scenarios (e.g. buy stocks, trade realty, etc.).

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APPENDIX

Jarnebrant, Toubia, and Johnson's research [6] focuses on silver lining effect (rule three of CRMA). They found that it is more likely to happen when (i) the gain is smaller (for a given loss), (ii) the loss is larger (for a given gain), and (iii) the decision maker is less loss averse. From the standpoint of value function, in a big-loss-and-small-gain situation, segregation is better only when the gain is smaller than a threshold. This threshold is larger when the size of the big loss is larger, and it is smaller when decision makers' tendency of loss aversion is smaller. The explanation is as follows:

As described in Kahneman and Tversky's research [9], the utility of gains and losses diminishes in both ends, and the curve of the value function on the loss side is steeper than the one on the gain side. When a small gain and a big loss are integrated, from the standpoint of value function, the curve of the reduced utility loss (contributed by the reduced loss caused by integrating the small gain) is far away (therefore relatively flatter than the one closer to the origin because of diminished sensitivity) from the origin on the negative side (therefore relatively steeper than on the positive side) of value function. On the other hand, when they are segregated, the reduced utility loss (contributed by the utility gain from the small gain) is close to the origin (therefore relatively steeper than the one far away from the origin) on the positive side (therefore relatively flatter than the one on the negative side) of value function. Therefore from the standpoint of value function, the comparison of the total utility loss between integration and segregation in big-loss-and-small-gain situations is actually the comparison of the steepness between the tail of the curve on the negative side and the beginning of the curve on the positive side. The size of the loss affects the position of the tail of the curve on the negative side. When the size of the loss is larger, because of diminished sensitivity, the tail of the curve on the negative side becomes flatter. Thus the small gain generates less utility when it is integrated to the big loss. So the combined utility loss in integration is larger, which makes segregation more favorable. When decision maker is less loss averse, the curve on the negative side is less steeper, which also makes the tail of the curve on the negative side become flatter and generate less utility. Therefore the combined utility loss in integration is also larger that make segregation more favorable, too. Fig. *A* illustrates this explanation. On the left-hand side of Fig. *A*, it can be seen that the utility gain of small gain *x* is larger when it is on the beginning of the curve on the positive side than when it is on the tail of the curve on the negative side. In this case, segregation has less total utility loss therefore is more favorable. On the other hand, when *x* becomes larger, the utility gain of *x* is larger when it is on the tail of the curve on the negative side than when it is on the beginning of the curve on the positive side. In this case, integration is more preferred. The picture on the right-hand side of Fig. *A* illustrates this situation.

Thresholds play an important role in their study as well as ours. The positions of thresholds in both studies are sensitive to the size of gains and losses. However, the cause of the thresholds is totally different. In our study, the threshold has nothing to do with loss aversion. On the other hand, their study is still based on the S-shaped value function proposed by prospect theory. Most importantly, our study focuses on multiple-gain and multiple-loss situations whereas theirs focuses on big-loss-and-small-gain situations. Therefore both studies are quite different. Perhaps we can say our study is the extension of rule one and two in CRMA and theirs is the extension of rule three in CRMA.

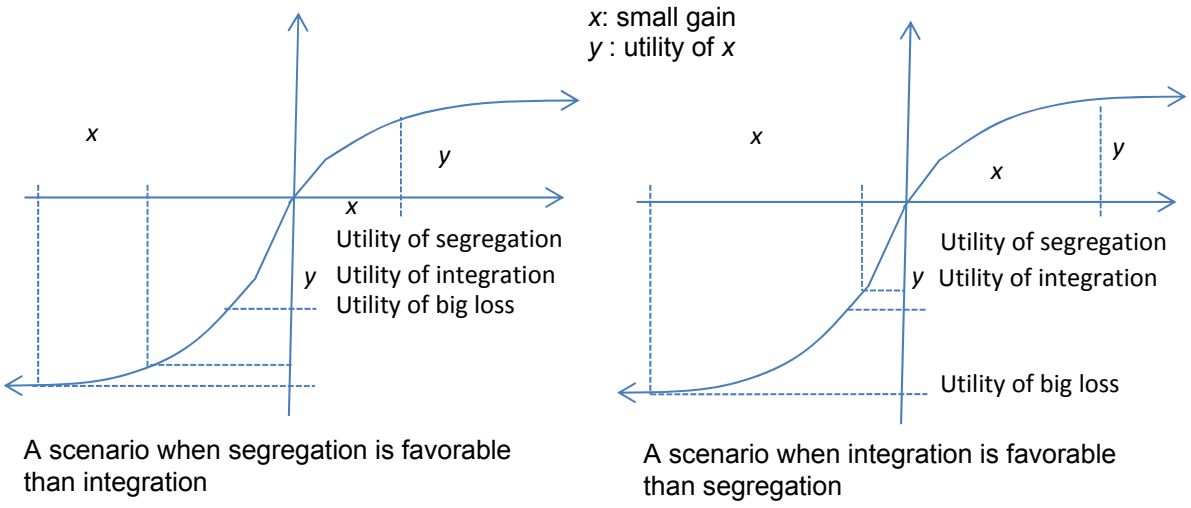

Fig. *A*. Scenarios that follows and against silver lining effect in big-loss-and-small-gain situations