**ERASMUS UNIVERSITY ROTTERDAM**

**Erasmus School of Economics**

**Bachelor Thesis【Programme IBEB】**

# Title thesis: The application of decoy effects in dynamic games

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## Abstract

*This paper studies whether the asymmetrically and symmetrically decoy options can be applied to motivate the people to improve decision makings in dynamic games. To investigate how individuals make the decision under the conditions with and without decoy options in real life as well as the dynamic game, I created the survey in three sets of experiments and 105 students from Shenzhen University were allocated to different groups to do the questionnaires. Also, the monetary incentive was considered to make the results more realistic and every participant can get the rewards based on what they chose. After that, the conclusion showed that decoy effects do not have significant effects on the individuals' decision makings in dynamic games.*



*Keywords: Pareto improvement, Rationality, Fairness, Asymmetrically decoy effect, Symmetrically decoy effect*



**This paper has been written as a Bachelor Thesis in IBEB at the Erasmus School of Economics, Erasmus University Rotterdam by Yu Chen (chenyuzhanjiang@sina.com ).**

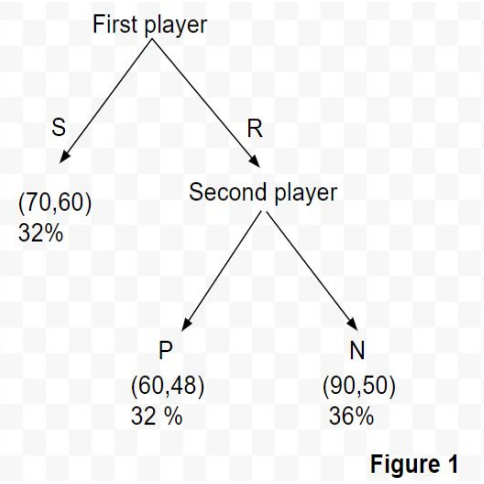
# Contents

# 1.Introduction

In traditional economics, people are modeled as selfish, in other words, rational persons in making every decision focus only on how much of their own interests, so as to make decisions to maximize their profits. And such a theory is also applicable to the standard game theory. “A game is a decision problem in which the final outcome depends not only on decisions of decision-makers but also on other players’ decisions”. Robert Aumann formally defined that players are selfish in the game and every decision made is to fully realize the maximization of self-interest (Robert Aumann, 1976). In addition, players also think that every decision that opponents made is selfish and rational in the game.

However, in recent years, more and more experiments have concluded that in the game, the rationality of human beings defined in traditional economics does not always hold (Goeree, J. K, & Holt, C. A, 2001). For example, in some cases, while making a decision, individuals focus not only on how much they can get in return, but also on the returns of other players, and ultimately make a decision. To achieve fairness, players are willing to sacrifice their own payoffs to punish the opponents. As a result, many behavioral economists started to use more psychological phenomena to speculate on people's behavior in game theory. “If somebody is being nice to you, fairness dictates that you be nice to him. If somebody is being mean to you, fairness allows – and vindictiveness dictates – that you be mean to him.” In 1993, Rabin stated the importance of fairness in games and also, the reciprocity model was implemented to predict the strategic behaviors. Additionally, Fehr, Ernst and Klaus M. Schmidt (1999) developed the Fehr-Schmidt-Model (FS Model) to capture the utility level of players’ inequality aversion in games. This model can be considered as a complement to the Rabin Model as it not only showed that players care about payoffs of others, but also it matters whether they are better or worse off compared to themselves.

However, based on inequality aversion, individual decision makings are not all rational considering the Pareto improvement. For example, in the dynamic game (**Figure 1**) that Goeree (2001) mentioned, as it is explained in the game rules, the player 1 makes the decision firstly and the player 2 decide what he/she choose under the condition that the player 1 already selected the option R. From the perspective of player 2, when facing two options, regarding choosing the N (no punishment) option, the player 2 yields 50 while the player 1 yields 90. By contrast, if player 2 chooses the P (punishment) option, he/she and another player get 48 and 60 respectively, which makes both of the two players receive less than in the N option. However, in the experiment of Goeree and Holt (2001), 32% of the players chose the P option,




Game rules:The first player and second player played these two games against each other. In both games, the first player was asked to choose between S and R. The second player was asked to choose between P and N. The second player’s choice was only implemented if the first player chose R to determine their final payments.

**Figure 1**

which was only 4% less than the players who chose the N option. This finding is also credible to confirm that fairness has a great impact on decision-making in the game. Even though choosing the P option makes the player 2 obtain less money, some of the players still select it in order to realize the fairness. It is important to note that many economists applied these psychological phenomena to games by observing people's behavior, but how to motivate those people to make rational choices in games seems to be a problem that has not yet been solved.

Therefore, in this study, a psychological mechanism named “decoy effect” was applied as a nudge in the game to help players make rational choices in terms of Pareto improvement. Decoy effect, proposed by Huber, Payne, and Puto in 1982, it has become a widely used psychological mechanism in marketing strategy. “A decoy is an alternative that is added to a choice set in order to alter the relatively attractiveness of the other alternatives in the set” ( Douglas.H.W, & Jonathan.C. P, 1996).

Consider a classic experiment done by Ariely and Chajut (1991). In their study (**Table 1**), all participants were divided into two groups to choose a microwave oven that they preferred to buy. In the group one, participants can choose microwave ovens A and B. Microwave oven A is expensive and good quality, Microwave oven B is less expensive but the quality is medium. In the group two, a decoy option called microwave A ' is added to the purchase list, in addition to the price that is higher than microwave oven A, it is similar to microwave oven A in other features. After the experiment, it was showed that in the first set of experiments, 60 percent of the participants chose microwave oven B and only 40 percent chose microwave oven A. But in the second experiment, the results were very different. 56% of the people chose Microwave A, 8% chose microwave oven A ' and 36% chose microwave oven B. It's obvious that the decoy effect is irrational. Because if consumers choose to prefer microwave oven A in the group one, then in the group two they should also choose to prefer A if the microwave oven A and B do not change with respect to all features

| | Group 1 | Group 2 |
|---|---|---|
| A (Expensive, high quality) | 40% | 56% |
| B (Less expensive, medium quality) | 60% | 36% |
| A’(More expensive, high quality) | Not shown | 8% |

(**Table 1**)

The explanation of this change in choice is mainly based on a theory in recent years. It is the idea of added value, proposed by Simonson (1989). Regarding this theory, when there is a decoy option, the target option would be compared with the competitor by always taking into consideration the advantage of the dominating relative to the dominated alternative. As a result, by comparing the target option with the decoy option, the advantages of the target option are further highlighted, but weaknesses are neglected, which also makes the decision maker who is hovering in the target option and competitive option, and therefore selects the

target option. As Dan Ariely (2009) described in his TED talk: "The option that was useless was useless in the sense that nobody wanted it, but it wasn't useless in the sense that it helped people figure out what they wanted." Hence, the value of the decoy option not depends on whether it can be selected, but its existence, making decision makers more determined to choose the target option.

However, while the decoy effect is a very popular strategy adopted by sellers in the marketing area, it had not been examined to be used as a nudge to influence real-world behavior until 2018. A nudge is an approach to behavioral change that "alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2008). In 2018, Meng Li, Yan Sun and Hui Chen, three psychologists from China, using longitudinal experiments in food-processing factories, showed that adding the decoy option that a worse sanitizer spray bottle effectively motivates the workers use the original sanitizer spray bottle more frequently. Hence, the results of their experiment described that this nudge increased workers' passing rate in hand sanitary tests from 60% to 70% to above 90% for 20 days. Also, in 2007, the influence of phantom decoy effect in games was first empirically investigated by Colman, A. M., Pulford, B. D., and Bolger, F. However, in their study, the game used to explore this effect was static and the decoy added in the games was phantom[1]. Therefore, in this paper, I consider the following three improvements over the previous research. Firstly, in addition to the use of health behavior, can decoy effect also be used as the nudge in game theory to help players make rational decisions? Secondly, apart from the static game, whether the decoy option is able to apply in dynamic games as well? Lastly, what happen in the game if a decoy option added in the game is available (not phantom) to choose?

Hence, the following research question is proposed as follow:

***Can the decoy option be used to nudge people towards Pareto optimal decisions in dynamic games?***

This study has a strong influence on the academic area as well as society. With respect to the academic relevance, the decoy effect, as a psychological mechanism, has rarely been implemented to have a positive effect in previous studies, especially for the game. And in this research, the application of decoy options in dynamic games will be analyzed, which enriches the applications of the decoy effect in real life situation. From the point of view of social relevance, the dynamic game is widely used in practice, such as auction, industrial organization, market competition, military campaigns as well as performance pay (Goeree, J. K, & Holt, C. A, 2001). Therefore, this study can also provide solutions to tackle more societal problems in the future.

The paper was organized as follow. After the introduction, the literature review was given and the research hypothesis was described in section 2. And then, the section 3 explained the experiment design. In section 4, the methodology was introduced and the information about the data was given in section 5. After that, results of the data analysis was presented to show the empirical evidence that whether the decoy effect is able to be implemented in

[1] The phantom decoy option is the option which is indeed showed in the game but not available for the players to choose it.

the dynamic game as a nudge to help people behave rationally regarding Pareto improvement in the section 6. Finally, in section 7, the conclusion was given including the limitations of this research.

## 2. Literature review

The asymmetrically dominated decoy effect (AD decoy effect, as shown in the **figure 2**) is one of the most extensively studied decoy effect. To be specific, the decoy option is said to be absolutely dominated by the target option when it is apparently inferior to the target option on at least one dimension and is identical or inferior to it on all other dimensions (Huber, Payne & Puto, 1982). In addition, compared with the competitive option[2], the decoy option is asymmetrically dominated since it is superior to the competitive option on at least one dimension and inferior or equal to it on other dimensions.

In contrast, the main difference between the symmetrically dominated decoy option (SD decoy option) and asymmetrically dominated decoy option is that the SD decoy option is absolutely dominated by both target option and competitive option in all dimensions as shown in the **figure 2**.

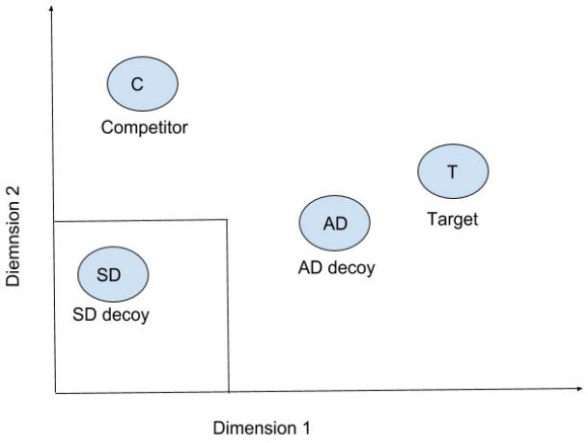



**Figure 2**

A famous case about the asymmetrically dominated decoy is its application in travel and tourism (Bharath M J & Hobson, 1995). In this research, the AD decoy effect was tested by using choices of tour packages to Las Vegas, Nevada, and Disney World, Florida. The introduction of decoy packages resulted in some consumers shifting their preferences to more expensive packages. Another interesting study was launched by Shanshan Zhen and Rongjun Yu in 2016. In this study, the relationship between the decoy effect and age was investigated, and experiments showed that children over the age of five were affected by the decoy effect, while in children under the age of five, no decoy was found to play a role in decision making. Therefore, according to these two studies, it is reasonably infer that if an asymmetric decoy is added to the game choice, the number of participants choosing the target option increases, because the decoy option highlights the advantages of the target option and makes it more appealing. This leads to the hypothesis one and two of this paper:

***Hypothesis 1: Asymmetrically dominated decoy option influences the buyers to choose the target option in real life situations.***
***Hypothesis 2: Asymmetrically dominated decoy option influences the player to choose the target option in dynamic games.***

[2] The competitive option is the option that competes with the target option to gain market share. From the perspective of marketing strategy, its presence is also the main driver of adding the decoy option.

Regarding the previous study of SD decoy effect, in 1991, Wedell found no significant effect of the SD decoys on choice. Furthermore, in 1993, Wedell further argued that the SD decoy led to a small but significant effect that favored the non-targeted option in choice. Hence, the hypothesis three is proposed as follow:

***Hypothesis 3: It is not expected to find an effect of the symmetric dominated decoy option on the player's decision making on the target option.***

## 3. Survey design

Regarding the experiment setting, all people involved in the survey were randomly allocated into three groups, control group, treatment group one as well as treatment group two. The participants from different groups are expected to answer different questions in survey. To be specific, a survey consisting of two parts with five questions totally was designed. The first part of the questions is about the personal information, and participants were required to answer questions about their major, gender as well as age. The second part of the questions is about the decision making in real life as well as dynamic game. In control group, the participants were asked to make the decision in the real life situation and original game without decoy option, while they were asked to answer the almost same question in treatment group 1 and 2 except the different decoy options were added.
Regarding the question about decision making in real life, it is about making decision on buying the most preferable popcorns, which had been firstly investigated by the National Geography Channel (2013), mainly explores if people are affected by decoy effects in purchasing popcorn when they go to see the movies with their friends. To be specific, in the control group, the participants were asked to select the preferred option between the large popcorn (700 g, 7 euros) and small popcorn (300g, 3 euros). In contrast, the participants were asked to make a decision on which item do they prefer among large popcorn, medium popcorn (500g, 6.5 euros, considered as the decoy option in this case) as well as small popcorn in the treatment groups. Based on this, whether the decoy effect has an influence on the individual decision makings of this targeted population has been investigated.

In addition to this, in this study, Goeree and Holt's dynamic game was used in our questionnaire as shown in figure 1. According to the FS model, the two important factors that players consider when making a decision are their own interests and the fairness of the return. Therefore, when designing these two decoy options, the two factors should be taken into account as core dimensions. Hence, in order to demonstrate hypothesis, the AD and SD decoy options were added to the game respectively as displayed in **figure 3** and **4**. Specifically, the AD decoy option showed an obvious disadvantage in terms of fairness compared to the target option, but it is identical to the target option on the personal return. Also, the SD decoy option is inferior to these two original options, with respect to

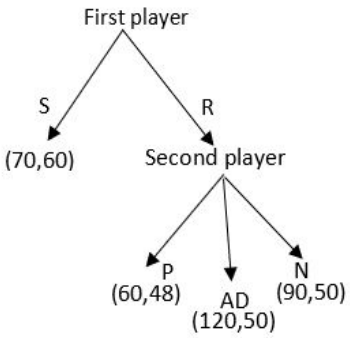



**Figure 3**

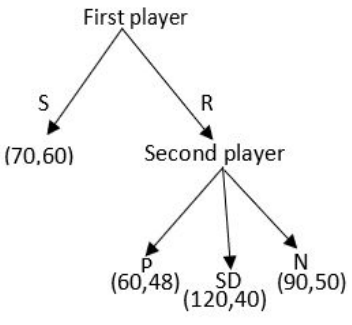



**Figure 4**

both fairness and personal returns.

Because this questionnaire mainly focuses on exploring the impact of the addition of the decoy option on the player's decision, so, due to simplicity, unlike the original rules of the game, in our survey, it was assumed that the first player has chosen the R option, and all participants choose from the N, P and the decoy option (if applicable) based on the perspective of the second player. Participants learnt the rules of the game through the game description firstly and then answered which option they would like to choose. More information about the survey questions can be expected to see in **table 2** below.

**Summary of the survey questions**

| | Control group | Treatment group 1 | Treatment group 2 |
|---|---|---|---|
| 1 | Name | Name | Name |
| 2 | Age | Age | Age |
| 3<br>(Large popcorn was counted as 3,medium popcorn was counted as 2 and small popcorn was counted as 1) | Make a decision on the real life situation without the medium option (decoy option). | Make a decision on the real life situation with the medium option (decoy option). | Make a decision on the real life situation with the medium option (decoy option) |
| 4<br>( N option was counted as 3, AD/SD option was counted as 2 and P option was counted as 1) | Make a decision on the game without the decoy option | Make a decision on the game with the AD decoy option | Make a decision on the game with the SD decoy option |
| 5<br>(Male was counted as the binary value of 1 and female was counted as 0) | Gender | Gender | Gender |

**Table 2**

## 4. Methodology

The methods used to analyze the survey data include normality test, Mann-Whitney U test as well as independent two samples T test. The software SPSS was applied to do the calculation in this study. In the remaining part of the section 4, these three methods were further explained respectively.

**4.1 Normality test**

Normality test is a statistical method to verify if a group of data follows a normal distribution (Asghar & Saleh,2012), which is also an important standard to measure whether the parametric test should be used in further analysis. Hence, it leads to the null hypothesis (H0) and the alternative hypothesis (H1) as follow:

H0: The sample follows a normal distribution.

H1: The sample does not follow a normal distribution.

In order to decide if the null hypothesis should be rejected, the SPSS software was applied to do the normality test. Also, the P= 0.05 significance level was used as the judgment. If the value of the normality test is smaller than 1.96 (P value > 0.05), it is not significant to prove that the sample is normally distributed, so the null hypothesis should be rejected. In contrast, the null hypothesis cannot be rejected if the sample is consider as normally distributed when the P value is smaller than 0.05. Based on this, it is clearly to know that whether the parametric test is able to be used.

Furthermore, if the sample size is big enough (N>=30), it is sufficiently assumed that the samples follow the normal distribution based on the central limit theory.

**4.2 Independent two samples T test & Mann-Whitney U test**

The independent two samples T test, which is also called the unpaired samples T test, commonly used to compare the means between two sets of data under the condition that the data is normally distributed. Also, it is believed that these two groups of data are independent with each other. For instance, if we plan to investigate whether the academic performance of boys and girls in school is the same, specifically, the average scores of boys and girls should be firstly computed, and then the average grades between boys and girls can be compared by independent two samples T test.

In this study, independent two samples T test was used for the main purpose of the following two points. On the one hand, as it is mentioned in the section 3, different questionnaires were randomly distributed to the three groups of participants. Hence, it is necessary to test if the means of the variables between them are significantly equal in order to examine if the individuals with different characteristics (gender and age) between the groups have been randomized.

On the other hand, once the randomness of individual characteristics has been confirmed, independent two samples T test can be used to explore whether the decoy effect has an impact on people in real life decision as well as in the dynamic game. In addition, as it is showed in the table 2, the numeric value was given when choosing different options in question 3 and 4. Take an example of the question 3. It is assumed that the average value obtained from the question 3 in control group is U1, while the average value obtained from the question 3 in treatment groups is U2. Therefore, the null hypothesis (H0) and alternative hypothesis (H1) are proposed as follow:

H0:U1=U2

H1:U1≠U2

After that, the null hypothesis can be decided to reject or not based on testing the statistical hypothesis. Moreover, as it is showed in the section 4.1, 5% significance level is used as the judgment; 10% significance level is used as a reference to show marginal significance.

Therefore, if the addition of the decoy option makes participants in treatment group more prefer to choose the target option than the control group, the average values will be not significantly same between the two groups. Based on this, whether the decoy effect affects individual decision makings can be clearly described.

The Mann-Whitney U test is a nonparametric test to measure if the mean of the variable in one group is significantly different from the mean of the variable in another group. Therefore, the purpose of using this test in the study is similar with the T test. However, compared with the independent two samples t-test that requires the data has to be normally distributed, the Mann-Whitney U test is able to use in the data that does not follow the specific distribution (Patrick & Julius, 2010).

## 5. Data

Due to limited budget and time considerations, all participants of the experiment are from Shenzhen University. In addition, in order to ensure the smooth running of the experiment, a student from Shenzhen University was recruited to distribute the survey to participants and collect them after participants finish them.

Regarding the process of data collection, during the first week of the May 2019, 200 questionnaires were printed and distributed to the different university students during the break of the class. Also, to promote participants in the survey to make decisions that are consistent with real life, monetary incentive and self-image concerns have been considered.

Regarding the monetary incentive, every participant got an amount of money based on what they chose. For instance, the people who chose N in the question 4 receive the monetary reward at 4 Yuan which is identical to 50 cents Euro based on the general exchange rate between China and Europe. In other words, participants were paid according to their decisions, which also make the survey results more realistic. However, every participant has maximum 10 minutes to answer the survey questions and has to hand in the survey on time otherwise their surveys cannot be taken into consideration and they are not able to obtain rewards. With respect to the image concerns, the participants were expected to fill in the questionnaire anonymously as Benabou and Tirole (2010) mentioned in their paper that “with the self-image concerns in minds, the people act prosocially in order to reassure they are nice people”.

At the end of the week, it was found that 120 students fully completed the survey and remaining 80 students’ surveys were not considered since some of the students did not hand in the survey on time and others did not fully finish the survey. What’s more, 15 questionnaires were removed from these 120 questionnaires as the participants filling out these questionnaires are majoring in economics and they had learnt the game theory before, so they are most likely to answer the questions based on pure rationality. Hence, 105

questionnaires were finally collected to use for data analysis. Of the 105 final selected questionnaires, 34 were questionnaires on the control group, 40 surveys were about the questions concerning the treatment group 1 as well as 31 surveys were involved in the questions regarding the treatment group 2. The summary of each variable from questionnaires concerning different groups was showed in the table 3 in results.

## 6. Results

Regarding the summary of descriptive statistics below, three points are worth to be mentioned here. Initially, it is clearly to notice the majority of participants are female and also, the proportions of female and male are almost identical among the three groups. Subsequently, concerning the question 3 about buying popcorns, the mode is same for every group but the average is different, which means that most of participants prefer to buy the small popcorns but the decoy option may affect their choice. Finally, the descriptive statistics of question 4 shows that the averages of different groups are similar but modes are completely different. In addition, as it is mentioned in the methodology, the normality test, t-test as well as Mann-Whitney U test should be further used in order to credibly examine if the effect is significant.

**Summary of Descriptive statistics**

| **Control group (obs:34)** | **Treatment group 1 (obs:40)** | **Treatment group 2 (obs:31)** |
|---|---|---|
| **Age** | | |
| Mean:24.11<br>Median:25<br>Mode:26<br>Standard deviation:2.73 | Mean:24.12<br>Median:23<br>Mode:22<br>Standard deviation:2.55 | Mean:24.3<br>Median:24<br>Mode:27<br>Standard deviation:3.21 |
| **Gender** (Male was counted as the binary value of 1 and female was counted as 0) | | |
| Mean:0.471<br>Mode:0<br>Standard deviation:0.51 | Mean:0.488<br>Mode:0<br>Standard deviation:0.51 | Mean:0.484<br>Mode:0<br>Standard deviation:0.51 |
| **Decision making in buying popcorns** (Large popcorn was counted as 3,medium popcorn was counted as 2 | | |

| | | |
|---|---|---|
| and small popcorn was counted as 1) | | |
| Mean:1.45<br>Median:1<br>Mode:1<br>Standard deviation:0.90 | Mean:1.90<br>Median:2<br>Mode:1<br>Standard deviation:0.91 | Mean:1.75<br>Median:1<br>Mode:1<br>Standard deviation:0.66 |
| **Decision making in the game** ( N option was counted as 3, P option was counted as 2 and decoy option was counted as 1) | | |
| Mean:2<br>Median:2<br>Mode:1<br>Standard deviation:1.02 | Mean:2.18<br>Median:2<br>Mode:3<br>Standard deviation:0.81 | Mean:2.03<br>Median:2<br>Mode:3<br>Standard deviation:0.93 |

**Table 3**

**6.1 Normality tests**

With respect to the results of the normality tests[3], it was presented that apart from the age of the control group, other data did not follow the normal distribution. Based on this, it is necessary to do the Mann-Whitney U test together with the independent two samples T test. The details were more explained in the following section.

**6.2 Independent two samples T test & Mann-Whitney U test**

Even though the results of the normality tests showed that most of the data are not normally distributed, I assume all data follow normal distribution and the independent two samples t-test is able to be applied since every group has at least 30 samples.

Table 4 and 5 demonstrate that the age and gender are not significantly different between group one and control group, group two and control group. Hence, it is convinced that all participants surveyed are randomly allocated to different groups and there is no selection bias in this study.

Table 6 compares the average of buying popcorns between treatment groups as well as the control group, and the difference is very significant, which demonstrates that the participants are definitely influenced by AD decoy option to more willing to purchase the target option. Based on this, the hypothesis one cannot be rejected.

[3] The results of the Normality tests are shown in Appendix.

Table 7 and 8 respectively illustrate that the means of game option between treatment group one and control group, treatment group two and control group do not show the significant difference. In other words, the AD and SD decoy effects have no influence on the players' decision making in dynamic games. Therefore, the hypothesis two can be rejected and hypothesis three cannot be rejected.

Regarding the Mann-Whitney U test[4], the results are similar to the results of independent two sample T test, which robustly illustrated that both of two decoy options have no significant influence on individuals' decision makings.

Compare means of age and gender between treatment group one and control group

| | | t | df | P-value | 95% Confidence interval of the difference |
|---|---|---|---|---|---|
| Age | Equal variances assumed | -0.195 | 72 | 0.846 | (-1.324,1.088) |
| | Equal variances not assumed | -0.194 | 70.449 | 0.847 | (-1.329,1.094) |
| Gender | Equal variances assumed | -0.091 | 72 | 0.927 | (-0.244,0.223) |
| | Equal variances not assumed | -0.091 | 71.633 | 0.927 | (-0.244,0.223) |

**Table 4**

Compare means of age and gender between treatment group two and control group

| | | t | df | P-value | 95% Confidence interval of the difference |
|---|---|---|---|---|---|
| Age | Equal variances assumed | 0.409 | 63 | 0.684 | (-1.171,1.775) |
| | Equal variances not assumed | 0.406 | 59.165 | 0.686 | (-1.184,1.788) |
| Gender | Equal variances assumed | 0.105 | 63 | 0.916 | (-0.238,0.265) |
| | Equal variances not assumed | 0.105 | 62.418 | 0.916 | (-0.239,0.265) |

**Table 5**

[4] The results of Mann-Whitney U test are shown in Appendix.

Compare means of popcorn between treatment groups and control group

| | | t | df | P-value | 95% Confidence interval of the difference |
|---|---|---|---|---|---|
| Popcorn | Equal variances assumed | 3.365 | 103 | 0.001 *** | (0.239,0.924) |
| | Equal variances not assumed | 3.756 | 86.413 | 0.000 *** | (0.274,0.889) |

**Table 6**

Compare means of game option between treatment group one and control group

| | | t | df | P-value | 95% Confidence interval of the difference |
|---|---|---|---|---|---|
| Game | Equal variances assumed | 0.694 | 72 | 0.490 | (-0.274,0.567) |
| | Equal variances not assumed | 0.683 | 65.052 | 0.497 | (-0.281,0.574) |

**Table 7**

Compare means of game option between treatment group two and control group

| | | t | df | P-value | 95% Confidence interval of the difference |
|---|---|---|---|---|---|
| Game | Equal variances assumed | 0.266 | 63 | 0.791 | (-0.419,0.548) |
| | Equal variances not assumed | 0.268 | 62.999 | 0.790 | (-0.417,0.546) |

**Table 8**

**(*** Significant at 1 percent level; **significant at 5 percent level; *significant at 10 percent level.)**

## 7. Conclusion

As it is described in the part of results, this study presents the empirical evidence that the AD decoy option does not positively influence the players to choose the target option in dynamic games. However, regarding the AD decoy effect applied in real life situations as well as the SD decoy effect, the outcomes of our research are indeed in line with previous study. To be specific, when facing the AD decoy option, people are more willing to purchase the target option compared with the case without AD decoy even if there is no change in both target option and competitive option themselves between these two situations; when facing

the SD decoy option, it is found that no significant relationship between the SD decoy and individuals' preference in choosing the target option. Considering the mental process of players, it makes sense since the SD decoy is inferior to both target option and competitive option in all dimensions and it cannot apparently emphasize the advantages of target option.

In addition, the limitations that exist in this study cannot to be ignored. First of all, as I mentioned above, because of funding and time considerations, all participants surveyed in this study are from Shenzhen University, which also makes the data results do not fully reflect the objective facts considering the external validity. Therefore, in the future research, I believe that the sample capacity should be more abundant. In other words, participants from different age groups, different cultural backgrounds are supposed to be investigated.

Secondly, even though the monetary incentive has been considered in the experiment, it is probably the case that the options chosen by the participants in doing the questionnaire were not consistent with their choices in real life situation because the payoffs they obtained may not be sufficient to motivate them to show their actual preferences. Hence, it is necessary to think about how to promote the participants to make the realistic decisions in the survey as well as possible in future research.

To sum up, even though this research has not empirically substantiated that the decoy effect is able to be applied in the dynamic games to realize the Pareto improvement, the key idea I am willing to come up with is that, in the future, economists are supposed to think further about how to apply the psychological mechanisms commonly using in marketing into the game theory, which probably be pretty helpful for addressing the societal problems happened fluently such as inequality, pollutions and so on.

## 8. Acknowledgement

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# 10. Appendix

**1. Descriptions of variables**

| Variable | Description |
|---|---|
| Age | |
| Gender | Male was counted as the binary value of 1 and female was counted as 0. |
| Popcorn | Large popcorn was counted as 3, medium popcorn was counted as 2 and small popcorn was counted as 1. |
| Game | N option was counted as 3, AD/SD option was counted as 2 and P option was counted as 1. |
| Decoy | The participants in control group were counted as 0, and 1 in treatment groups. |
| AD | The participants in control group were counted as 0, and 1 in treatment group one. |
| SD | The participants in control group were counted as 0, and 1 in treatment group two. |

**2. Normality tests**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | P-value | Statistic | df | P-value |
| Age (control group) | 0.248 | 34 | 0.000 *** | 0.824 | 34 | 0.000 *** |
| Age (treatment group one) | 0.231 | 40 | 0.000 *** | 0.871 | 40 | 0.000 *** |
| Age (treatment group two) | 0.079 | 31 | 0.200 | 0.978 | 31 | 0.749 |
| Gender (control group) | 0.353 | 34 | 0.000 *** | 0.636 | 34 | 0.000 *** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gender (treatment group one) | 0.351 | 40 | 0.000 *** | 0.636 | 40 | 0.000 *** |
| Gender (treatment group two) | 0.346 | 31 | 0.000 *** | 0.638 | 31 | 0.000 *** |
| Popcorn(control group) | 0.523 | 34 | 0.000 *** | 0.378 | 34 | 0.000 *** |
| Popcorn (treatment group one and two) | 0.325 | 71 | 0.000 *** | 0.721 | 71 | 0.000 *** |
| Game (control group) | 0.338 | 34 | 0.000 *** | 0.638 | 34 | 0.000 *** |
| Game (treatment group one) | 0.270 | 40 | 0.000 *** | 0.783 | 40 | 0.000 *** |
| Game (treatment group two) | 0.295 | 31 | 0.000 *** | 0.729 | 31 | 0.000 *** |

**3. Mann-Whitney U test**

- **Compare means of popcorn between treatment groups and control group**

Ranks

| | Decoy | N | Mean rank | Sum of ranks |
|---|---|---|---|---|
| Popcorn | 0 | 34 | 40.38 | 1373 |
| | 1 | 71 | 59.04 | 4192 |
| | Total | 105 | | |

Test statistic

| | Popcorn |
|---|---|
| Mann-Whitney U | 778 |
| Wilcoxon W | 1373 |
| Z | -3.431 |
| P-value | 0.001 *** |

- **Compare means of game option between treatment group one and control group**

Ranks

| | AD | N | Mean rank | Sum of ranks |
|---|---|---|---|---|
| Game | 0 | 34 | 36.63 | 1282 |
| | 1 | 40 | 39.20 | 1568 |
| | Total | 74 | | |

Test statistic

| | Game |
|---|---|
| Mann-Whitney U | 652 |
| Wilcoxon W | 1282 |
| Z | -0.554 |
| P-value | 0.580 |

- **Compare means of game option between treatment group two and control group**

Ranks

| | SD | N | Mean rank | Sum of ranks |
|---|---|---|---|---|
| Game | 0 | 34 | 32.50 | 1105 |
| | 1 | 31 | 33.55 | 1040 |
| | Total | 65 | | |

Test statistic

| | Game |
|---|---|
| Mann-Whitney U | 510 |
| Wilcoxon W | 1105 |
| Z | -0.249 |
| P-value | 0.803 |

**(*** Significant at 1 percent level; **significant at 5 percent level; *significant at 10 percent level.)**