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The influence of personal characteristics and reference dependence in risky decision-making for a high-stakes game show

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Abstract

This paper takes a look at the decision-making of contestants in the game show "De Postcode Loterij Miljoenenjacht", the format that is also known as "Deal or No Deal" in countries outside The Netherlands. I have sampled 41 episodes looking for differences in decision-making caused by gender and age. No significant effects were found but this might be related to the fact that the semi final has characteristics of a "selection round". In addition I looked for signs of reference dependence in the data. The data showed "Winners" and "Losers" were less likely to deal compared to their "Neutral" counterparts. This proves that the course of the game is relevant to what decision a contestant will make at the end of the round. My theory for "Winners" not only includes effects of reference dependence but also the overvaluation of small probabilities.

Keywords

Decision making under risk; game show; risk preferences; risk aversion; prospect theory; deal or no deal

Introduction

If I look back on the three years of economics education and have to name one core concept of the program that was of most importance it would be decision-making. Whether it was deciding what investment to pursue, what product to buy in the market or how to decide in games according to game theory. But knowing how to optimally decide, or decide rationally, isn't everything. What is optimal? What is your definition of rational? How optimal would individuals choose if there was a lot of risk and emotions involved? The theory, which will be discussed in the next section, suggests certain decision patterns in risky environments with respect to personal characteristics. Basically the theory tells us that women are more risk averse than males and younger people are more risk seeking than older people (Denberg et al.,

1999; Sanfrey & Hastie, 2000; Powell & Ansicc, 1997). I am curious to see if I can contribute empirics to these hypotheses. I have chosen to use a popular game show on Dutch national television called "De Postcode Loterij Miljoenenjacht", also known as "Deal or No Deal" in other countries such as for instance The United States of America. In this game show the contestant has the chance of winning up to €5.000.000 but theoretically can also go home with €0,01. A show in which emotions run high and the contestant is numerously put on the spot to make quick decisions that can make or break the prize outcome the constant will take home. A perfect environment to test risky decision-making. In addition to testing for effects of gender and age I am going to test if the concept of "reference dependence", which will be explained in the literature review, influences the decision-making of the contestant. The main focus of this paper will be how do contestants decide in various situations or moments in the game. The following research question will be answered over the course of this paper:

Do gender and age influence the way contestants make risky decisions in the game show "De Postcode Loterij Miljoenenjacht", and does reference dependence play a role in this decision-making?

My hypothesis is that women will play the game more risk averse or safer than men, also older contestants will play more risk averse than younger players. In addition, reference dependence is an important factor in this game. The way contestants are performing in the game is essential to how they will play it.

The structure of this paper is as follows. In section I, I review literature relevant to this subject as a foundation of the research. Section II is devoted to explaining the game show used in detail. Section III contains preliminary results such as descriptive statistics of the sample, a scatterplot of the bank offer and some basic decision-making statistics. In section IV I present a probit regression including age and gender variables. Section V shows analysis with respect to proof of reference dependence being an important factor in risky decision-making. Finally there are some concluding remarks and suggestions for further research in section VI.

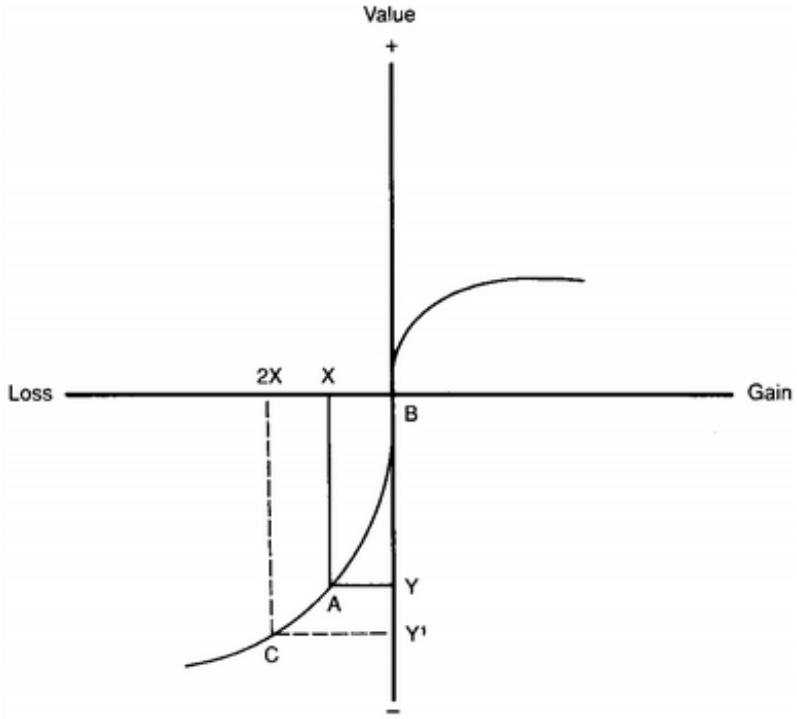
I: Literature review

To analyse the behaviour of the contestants we want to use a model that fits. A good normative model would be the Expected Utility. One of the assumptions this model makes is that the subjects are risk averse. To define risk aversion, a person is risk averse when he or she prefers the value X to a gamble with the expected value of X. The model describes the risk aversion to be the result of utility having marginal diminishing returns that make the utility function concave in nature. To make the model more fitting it is possible to add some extensions like the "weighted utility theory" (Chew & Maccrimmon, 1979), and the "disappointment theory" by Bell (1985) and Loomes & Sugden (1986). The former suggests that subjects' risk aversion becomes stronger as the "prospects", the options at hand, improve. The latter assumes that if the outcome of the decision involving risk is worse than prior expectations, the subject will experience disappointment. However, if it's better than expected the subject will experience delight and excitement. This extension describes that subjects are not necessarily just risk averse but also disappointment averse. With the function of utility being concave in the positive gains portion of the function and convex in the losses part of the function.

This model does however not account for the psychological mechanisms or processes in the decision-making. Bounded rationality and the use of decision heuristics must be included. Bounded rationality describes that the subject has incomplete information in a dynamic and complicated decision setting and the subject is not perceived to be a "human calculator". With the Expected Utility Model being a conventional model the most influential non-conventional model is the Prospect Theory (Kahneman & Tversky, 1979). This model is mostly descriptive; it doesn't describe what subjects should do but what they actually do. In this perspective this model would be more suited for this type of research. It is divided in two subsequent phases. In the first phase the subject edits the options, so he or she is able to evaluate the options and choose one in the second phase. In the Prospect Theory outcomes are evaluated based on a reference point. This could for example be the current situation or the prior expectations of what the outcome will be. Brickman & Coates (1978) showed that winning the lottery increases happiness in the beginning, but when the reference point

shifts to the current situation the level of happiness is again in line with non-lottery winners in less than a year. The research paper also made a comparison between lottery winners and victims of paralysis and showed more or less equality in levels of happiness because of the reference point phenomenon. The “Easterlin Paradox” also shows empirical evidence for reference points. Rich people tend to be happier than poor people, but rich developed countries are not significantly happier than poor developing countries. If the real income of a country increases, it will not result in increases in happiness. (Easterlin, 1995). The Prospect Theory uses the following utility curve:

Image 1: Reference point utility/value function in the Prospect Theory

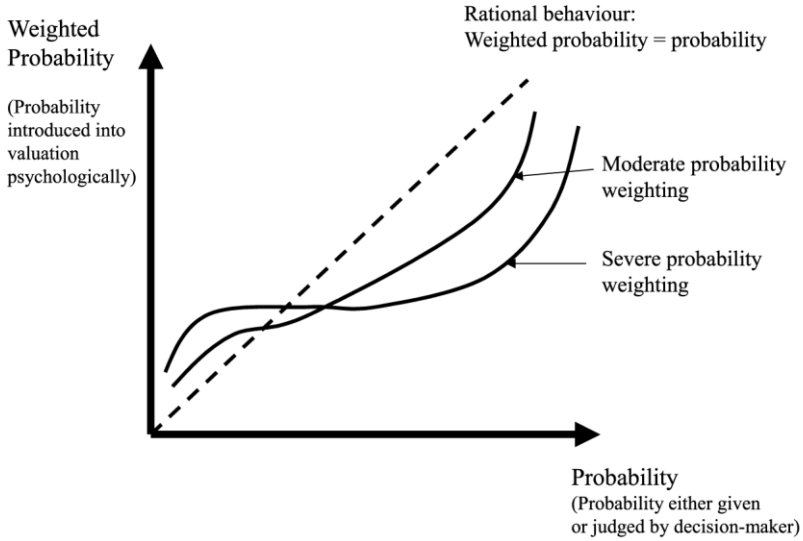


Source: By Garland, Howard; Sandefur, Craig A.; Rogers, Anne C.
Journal of Applied Psychology, Vol 75(6), Dec 1990, 721-727.

It has a concave, risk averse, portion in the positive gains area and a convex, risk seeking, portion in the losses area. All based around the centre that signifies a reference point. To illustrate, the amount of utility of winning $100 is smaller than the amount of disutility of losing $100. The convex characteristic of the losses portion is explained by risk seeking behaviour to offset the loss. Pinker (1997) proposed a reason why people are risk averse on an evolutionary standpoint. Gains, for example water or food, might improve survival and replication. But losses in this category

could be fatal. In addition to the basic Prospect Theory utility curve, it also has a special probability weighing function. In the Expected Utility Theorem subjects only consider the objective probabilities of occurrence but this does not need to hold in reality. The Prospect Theory has shown that in reality people overvalue small probabilities (Kahneman & Tversky, 1992), which could be the reason why we consider insurances. Image 2 illustrates examples of possible probability weighting functions. So as the theory suggests, a psychological transformation of objective probabilities into subjective decision weights, which indicates the impact the event has on the decision (Glimcher, Camerer, Fehr, & Poldrack, 2008).

Image 2: Probability weighting function of the Prospect Theory



Note: A decision-maker showing more severe probability weighting will find the move from a 35-40% chance of success to a 90-95% chance of success more attractive than would a decision maker will less severe probability weighting

Source: Philip A. Wickham, (2006),"Overconfidence in new start-up success probability judgement", International Journal of Entrepreneurial Behaviour & Research, Vol. 12 Iss: 4 pp. 210 - 227

Choices can be different when small probabilities are involved. Although small probabilities get more weight than they deserve in risky decision-making, they still tend to get underweighted in decisions that involve experience. Unless they have recently occurred, in that case the probability is hugely overweighed. (Weber, 2006).

There have been numerous research papers written about decision-making under risk in game shows with large payoffs. One of which included samples of the game show I wish to study further, “De Postcode Loterij Miljoenenjacht”. A TV formula produced

by the Dutch Production Company Endemol, which has been sold to numerous countries. The show in other countries is better known as “Deal or No Deal”. Although the variant in each country in which it airs is practically the same, the main difference is that the Dutch version is sponsored by the national lottery thus allowing for higher potential prices with a maximum of five million. Post et al. (2008) found “moderate risk aversion” in the data; Deck et al. (2008) came to the same conclusion with the Mexican version but suggested that it was related to the cultural differences surrounding wealth and it’s appreciation. The contestants mostly reject high offers of the bank, sometimes exceeding 75% of the expected value of the money still in play. Although a lot can be explained by the variation of risk preference per contestant, they have also found a relationship between the round the contestant accepts the bank offer and what happened in the round before. For instance, if a contestant opens a case containing a very large amount it resulted in a sense of loss with respect to the reference point of the previous round. Making the contestant increasingly risk seeking in pursuit of reaching that same reference point once again. They label this a “path dependent pattern” (Post, Van Den Assem, Baltussen, & Thaler, 2008). They also concluded that ‘Winners’ and ‘Losers’ are less likely to deal than their neutral counterparts. Winners and losers referring to contestants who either doing very well or very bad in the game. The main take-away of their research was that previous events frame current decisions.

However there was no conclusive evidence in their research pointing towards explanatory power of the contestants’ characteristics like age, gender and education. This is strange because research has shown that older people take longer to come to an conclusion concerning the choice, are more risk averse compared to younger subjects, and are more likely to choose less optimal (Denberg et al., 1999; Sanfrey & Hastie, 2000). Also it is proven that females are more risk averse, irrespective of familiarity, framing, costs or ambiguity (Powell & Ansic, 1997).

II: The mechanics of the game-show

“Deal or No Deal”, also called “De Postcode Loterij Miljoenenjacht” in the native Dutch language, is a high stakes game-show developed by the Dutch production

company Endemol. The same company that was the creator of formats like “Who wants to be a Millionaire?”, “Dancing with the stars” and “Big Brother”. The “Deal or no Deal” concept was popularized following it’s debut on Dutch television in December 2002 and has been sold to more than fifty countries across the world. However, in this paper we are going to solely focus on the Dutch version. Although the differences between the Dutch version and foreign ones are slight, there is one significant difference concerning the price money involved. Because of the show being sponsored by the national lottery the contestant can theoretically win up to €5,000,000. This makes the show not only more entertaining, but also more suitable as a high stakes risky decision-making experiment.

Ten random Dutch postal codes are selected, each of which fifty participants of the national lottery are invited to attend the show. The audience is made up of five hundred people divided in ten sections named after their village or city connected to the postal code. The game is split up in three parts. First there is a general elimination game cutting down the 500 participants to 2, then comes the semi-final and after that one participant gets to play the final. This final will be our focus point of the paper.

In the first part each individual audience member has to answer a couple of multiple-choice questions. The participant in each section who has the most correct answers and who answers them the fastest is selected to advance to the next round. The remaining 490 people are eliminated. The 10 contestants are paired up in two’s, to face-off against each other. The host will ask a binary question to the audience and the two contestants have to guess how the audience answered this question as a whole, for instance how many audience members have answered “A” instead of “B”. The one who is the closest to the correct amount advances to the next round and the other is eliminated. The 5 remaining contestants will again have to compete with each other by answering questions with ultimately eliminating three more contestants; the two remaining contestants will proceed to the semi-finals.

In the semi-final the two players get the opportunity to introduce and tell something about themselves. They will stand in front of each other each having a big button in arms reach. With 1 player being permitted in the final the semi-final is basically giving both contestants the incentive to voluntary give up the opportunity to go to the

final round by accepting a sum of money. What will happen is the big screen will show the amount of €1000,-. This €1000,- will rapidly increase up to an unknown amount which is different in every episode. When one of the two players is content with the current amount shown on the big screen he or she can press the button and that particular contestant will receive that amount as price money and eliminate him or herself, whereas the other contestant will go to the final. There are two situations that can occur. The first one, obviously, one of the players will push the button and receive the amount on screen giving the other player the spot in the final. The second situation is as follows, if both players refuse to press the button and the amount reaches the unknown limit they will have to do a tie breaking math problem. A math problem like "253 – 179 =" will appear on screen. The first to press the button and give the right answer advances to the final; the other goes home with nothing.

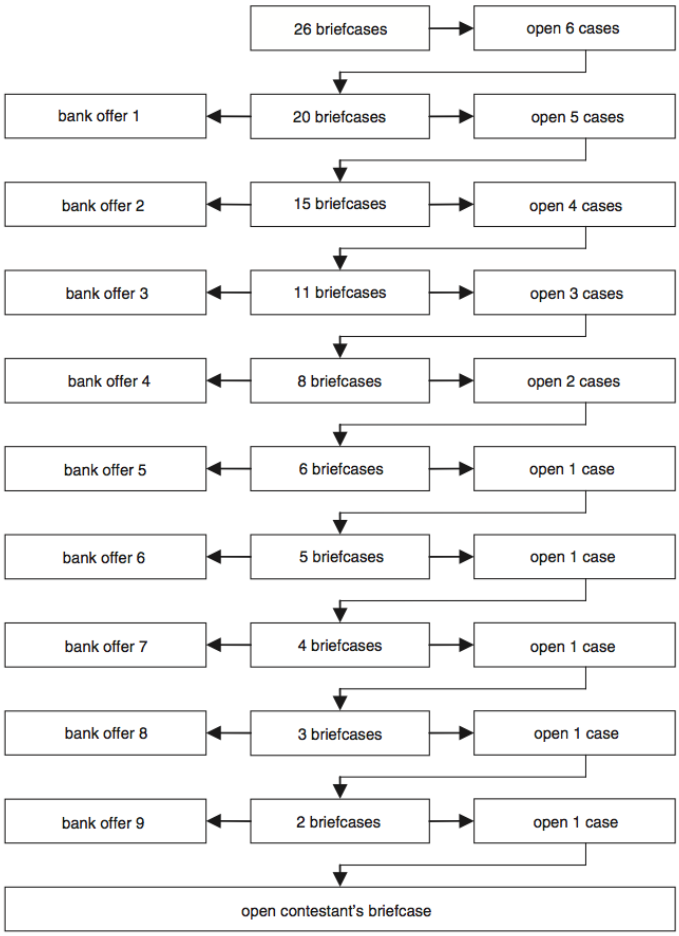
Image 3: An illustration of the final round on June 1st 2008 a few minutes before Stijn was offered €1.050.000

Source: RTL 4

In the final the contestant has to choose one of twenty-six closed suitcases, each

containing amounts ranging from €0.01 to €5.000.000 as his or her suitcase. In the first round the contestant has to open six of the remaining 25 suitcases, the price money that is inside these cases will be eliminated. At the end of the first round the bank calculates an offer for the contestants suitcase based on what price money is still in play. The contestant can either choose to accept this offer and elect to “Deal” and go home with the amount being offered, or decline this offer and proceed to the second round. In the second round the contestant will have to open five more suitcases after which the contestant will receive another bank offer for his or her case based on the price money left. She can either accept the deal and go home with the offer or decline it and go on to the third round having to open four suitcases. This goes on until the beginning of round six. From that moment on she will have to open a single suitcase each round, if she chooses to continue playing after having seen the bank offer at the end of each round. At the end of round ten when there are two cases left, the contestant can either accept the offer that is being presented or decline it and receive the contents of his or her own case. As an illustration, the final in flowchart form:

Image 4: A flowchart of the final round



Source: Post et al. (2008)

III: Preliminary results

I have collected the data of 41 episodes of "De Postcode Loterij Miljoenenjacht". The first episode included in the sample aired on December 7, 2008, and the last on May 6, 2012, building forth on the sample provided by Post et al., 2008. The show actually aired 42 times during this period but unfortunately one episode was removed due to technical difficulties retrieving it from the Internet. For each episode I collected the relevant data. First I elicited the gender and age group, 20-30, 30-40, 40-50, 50-60, 60+ years from a small contestant introduction talk at the beginning of the semi-final. The age was sometimes shared but most frequently estimated from how old the contestants' kids were, or how long the contestant was married. Then I noted if the button was pressed or not in the semi-final, if so how much money the runner up accepted. And for the final I archived for each round which amounts of money were eliminated, what the expected value of the contestant's case was, what the bank offer was, and if the contestant elected to "Deal" or "No Deal". Table 1 shows some descriptive statistics about the sample used in this paper following the format of Post et al., 2008.

Table 1: Descriptive Statistics (N = 41)

	Mean	St. dev.	Min.	Median	Max.
Agegroup (1-5)	3,07	1,26	1	3	5
Gender (Male = 1)	0,61	0,49	0	1	1
Ending round	5,44	1,66	3	5	10
Best offer rejected (%)	48,80	20,20	11,10	42,80	91,99
Bank offer accepted (%)	60,57	19,85	9,61	60	100

Money won (€)	210.121,95	218.670,18	500	345.000	1.050.000

Notes: This table shows a summary of statistics derived from the 41 episodes included in this research, excluding the semi-final. The age was elicited from the small talk the host and the contestant have at the beginning of the semi-final. It is based on the contestant telling the audience his or her actual age, otherwise from the age of the contestant's children or marriage duration. The five age groups are ordered from young to old having the values of 1 to 5. These groups are in ascending order: 20-30, 30-40, 40-50, 50-60, 60+ years. Gender is a dummy variable with the value 1 assigned to males and the value 0 assigned to females. The ending round stands for the round in which the contestant chose to accept the bank offer and end the game. If the contestant wishes to go to the final round and open their own case it will receive the value of 10 The best offer rejected (%) is a bank offer as a percentage of the expected value of the remaining price money at the end of the same round, which is highest or second highest depending on whether or not the final deal was the best deal percentage wise. The bank offer accepted is the bank offer as a percentage of the remaining prize money for each made deal. Amount won stands for the monetary amount of prize money gathered by the contestants.

Table 1 shows us that relatively more males than females participated in the final according to the sample used for this research. On average they were between 40 and 50 years old, they chose to stop the game at the end of the fifth round and accepted offers averaging out on 60,57% of the expected value of the remaining prize money. The least fortunate contestant went home with €500 after having rejected the final bank offer of €88.000 and embarking on a fifty fifty gamble between €500 and €200.000. The most fortunate contestant had the privilege of going home with €1.050.000. The average prize money won is €210.122, but based on experience this is practically around €100.000. Some outliers, like for instance the €1.050.000 grand prize, make the distribution right skewed.

Table 2 illustrates some statistics about the "Deal" or "No Deal" decision behaviour accompanied by the averages of bank offers and the expected value of the remaining prize money for each particular round. As you can see it is divided in three categories following the concept used in Post et al., 2008. The first category subsection "All subjects" includes all samples. The second category is "deal", which entails only the cases in which the contestant deals, and the third and final category "No Deal" only includes all the cases in which the contestant does not deal. The first thing that can be observed about the table is that nobody chose to "Deal" in the first two rounds. The table also shows that the bank offer usually starts relatively low, in the 6% category, and increases as the game progresses. If the contestant has played all the way up to the end of round nine the contestant is most likely to get an offer close to 100% of the expected value. However, I have not yet encountered a case in which the contestant gets an offer that is more than 100% of the expected value as was found in Post, et al

2008. As for the difference between "Deal" cases in contrast with "No Deal" cases is that the cases in which a contestant deals he or she has a higher percentage bank offer and also a higher expected value of remaining prize money. This relation does not hold for the final two rounds looking at the expected value, perhaps for lack of sample size or outliers in risk-seeking profiles.

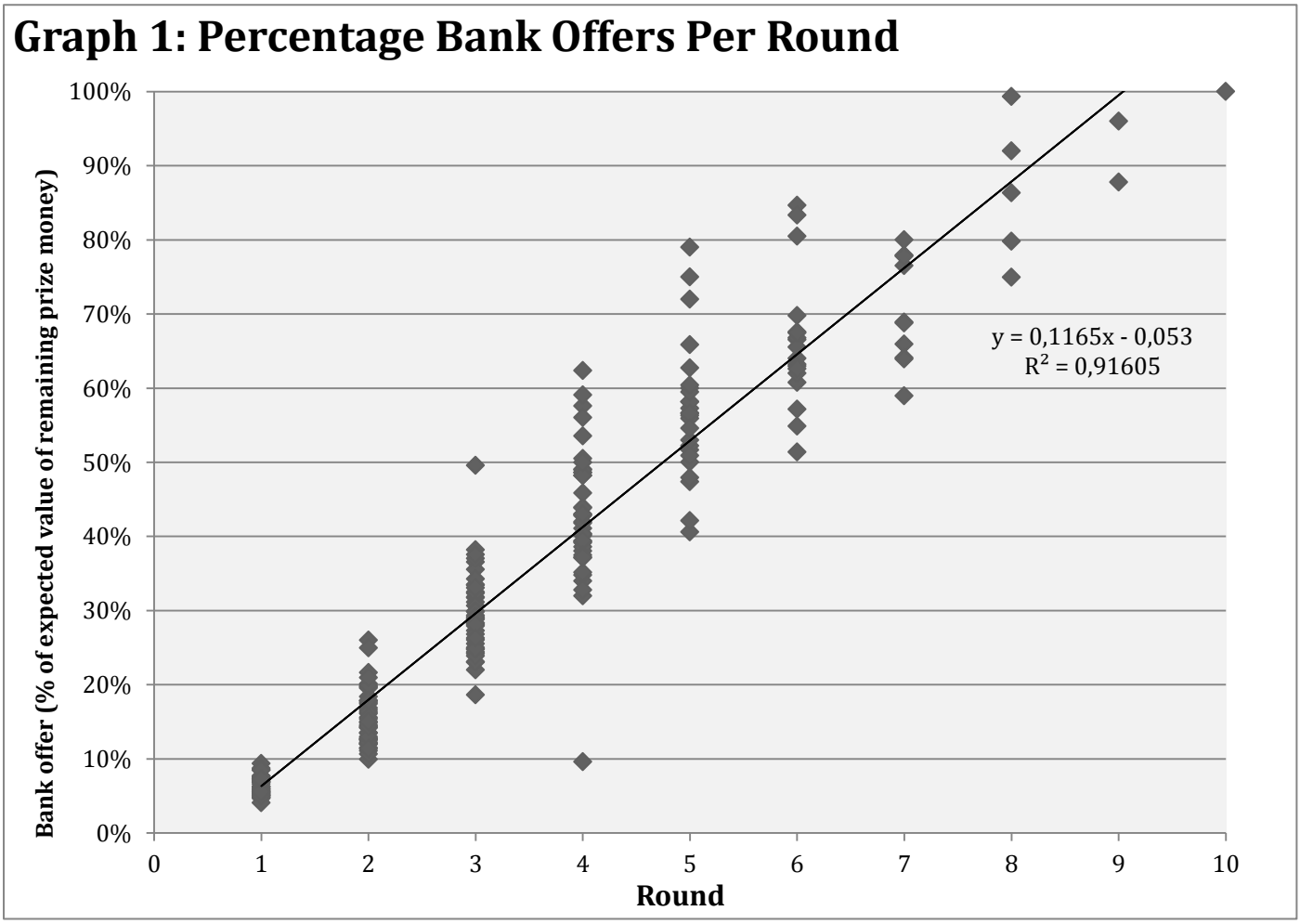
Table 2: Preliminary analysis 'Deal or no Deal' decision-making (N = 223)

	All subjects			**Deal**			**No Deal**		
Round	%BO	Exp. Val.	No.	%BO	Exp. Val.	No.	%BO	Exp. Val.	No.
1	6	424.984	41	-	-	0	6	424.984	41
2	16	390.275	41	-	-	0	16	390.275	41
3	30	373.428	41	32	470.417	2	30	368.454	39
4	43	370.263	39	44	383.677	14	42	362.751	25
5	57	364.384	25	57	396.941	7	57	351.723	18
6	66	394.521	18	71	609.192	8	62	222.784	10
7	70	203.330	10	74	261.327	5	67	145.333	5
8	87	103.443	5	89	86.239	3	83	129.249	2
9	92	56.376	2	96	12.502	1	88	100.250	1

Notes: This table summarizes the preliminary results concerning the bank offers percentage, the average remaining price money and the deal or no deal decisions made by the contestants. The sample includes 41 episodes. The table is divided in three categories. The first category "all subjects" combining all samples, the second category "deal" includes only the cases in which the contestants deal and the final category "no deal" focuses on the cases in which the contestants do not deal. For each category there are 3 variables used in analysis. %BO is the bank offer as a percentage of the average remaining prize money at the end of the round, Exp. Val. is the average remaining prize money at the end of the round and No. is the number of cases.

Now we are going to take a closer look at the bank offers to see if the offers are being determined in some sort of consistency. The data, illustrated in graph 1, shows a strong linear relationship between the bank offer percentage (%BO) and the round number. Using a trend line it shows the linear relationship with a R^2 of 0,91605. There was also a significant correlation between the average prize money and the absolute bank offer but this is most likely a non-casual correlation being that in theory the former is derived of the ladder. My reasoning for occasional deviating pattern of the bank offer is that the amount is rounded off to thousands. It is also possible that the offer is sometimes being influenced based on what amount the semi-finalist won, offering the contestant less inducing a rivalry to incentivize the contestant to keep on playing. We did find a different bank-offering pattern for contestants that were not doing well relatively and for those that were doing well relatively. This will be explained in more detail in the next section.

Graph 1: Percentage Bank Offers Per Round



Notes: This graph illustrates the percentage bank offers per round. The bank offer, as a percentage of the average remaining prize money, is located on the y-axis and the round on the x-axis. The data showed a clear linear relationship as pointed out by the included trend line. The function used as trend line is y = 0,1165x – 0,053 and has an explanatory power of 91,6%.

IV: Probit Regression with Gender and Age Variables

In this section I would like to present the results of the probit regression, derived from the technique used by Baltussen et al, 2012. The dependent variable is the contestant's decision, with the value of 1 when the contestant makes a deal and the value of 0 when the contestant does not make a deal. EV/100 is a variable added to control for the prize money involved and resembles the average amount of prize money left in the current round subsequently divided by 100 for easier coefficients. EV/BO is included to control for the relative attractiveness of the offer versus the current expected value of prize money. The Stdev/EV is added to account for the riskiness of continuing play and is a division between the standard deviation of the distribution of the average remaining prize in the next round divided by the expected value of the price money in the current round. Gender is also included with the value of 1 for female and the value of 0 for male. Finally the variable Age Group is included which can have the values 1, 2, 3, 4 until 5. The categories in ascending order are: 20-30, 30-40, 40-50, 50-60, 60+ years. Once again the age was derived from an introductory talk at the beginning of the semi-final. Mostly the exact age was told but sometimes I had to estimate the age from the age of his or her children or how long the contestant has been married. The results are in table 3.

Table 3: Probit regression results

	Coefficient	Prob.
Constant	0,681	(0,167)
EV/BO	-0,366	(0,000)
EV/100	2,91E-05	(0,535)
Stdev/EV	-0,107	(0,230)
Gender (1 = Female)	-0,312	(0,187)
Age Group [1,5]	-0,073	(0,446)
McFadden R^2	0,245	
Log Likelihood	-80,31	
No. Obs.	223	

Notes: This table shows the results of a probit regression trying to explain the decision behaviour of 41 contestants. These 41 contestants had to make 223 decisions that subsequently are the number of observations. The dependent variable is the contestant's choice, with "Deal" having the value of 1 and "No Deal" having the value of 0. EV/BO is the expected value of the remaining price money divided by the absolute bank offer. EV/100 is the expected value of the remaining price money divided by 100. Stdev/EV is the standard deviation of the distribution of the average remaining price money in the next round divided by the average remaining price money in the current round. Gender is a dummy variable with the value of 1 for female and the value of 0 for male. Age Group is the age variable that can have the values 1 through 5. With 1 being the youngest and 5 being the oldest. The groups in ascending order are: 20-30, 30-40, 40-50, 50-60, 60+ years. In addition to the coefficients the McFadden R^2 is included as well as the Log Likelihood and the number of observations.

The model has a R^2 of 0,245. However, only the EV/BO is significant. The coefficient is negative meaning that if the expected value of the remaining price money is much greater than the bank offer; the contestant is more likely not to deal. The variables of both Gender and Age Group are not significant thus giving no proof for my hypothesis that the decision-making changes with age or gender.

However, the lack of significance of gender might have something to do with the semi-final. If the theory is correct and women are on average more risk averse they would be more likely to opt out in the semi-final thus not be included in the regression sample used. The semi-final can be seen as a selection phase in which risk seekers who are less likely to press the button are more likely able to reach the final. So the regression might fall short on showing an effect of gender, or age for that matter, on decision-making and risk preference because winners of the semi-final will frequently have a similar risk preference. In the semi-final there are three possible matchups: A male versus a male, a female versus a male, and a female versus a female. The percentages of "Female vs. Female" and "Male vs. Male", shown in image 5, do not show any obvious differences. Not in the percentage "Pushed The Button" or in the percentage "Nobody Pushed". Neither do the absolute amounts pushed show a difference between categories as shown in table 4.

Image 5: the Pct. (%) distribution of the semi-final with same gender match-ups

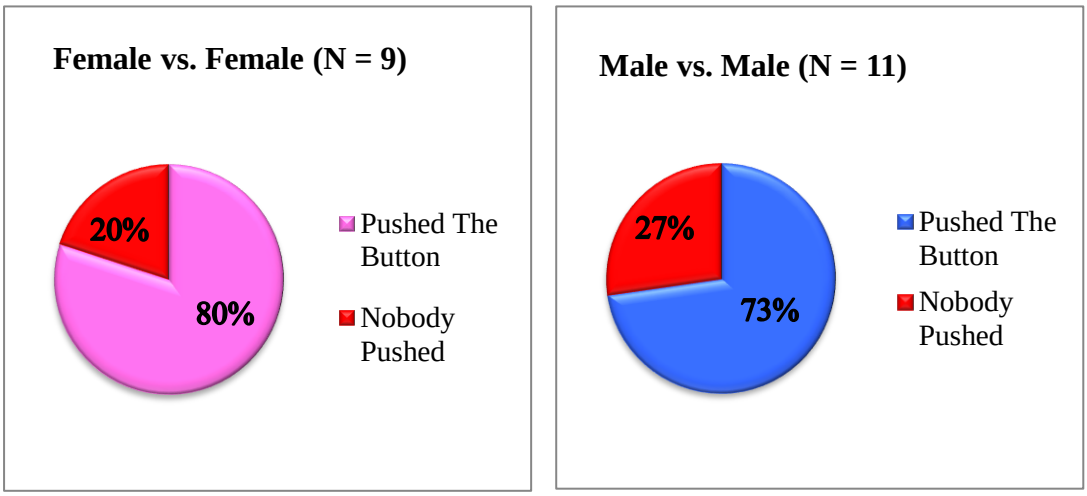


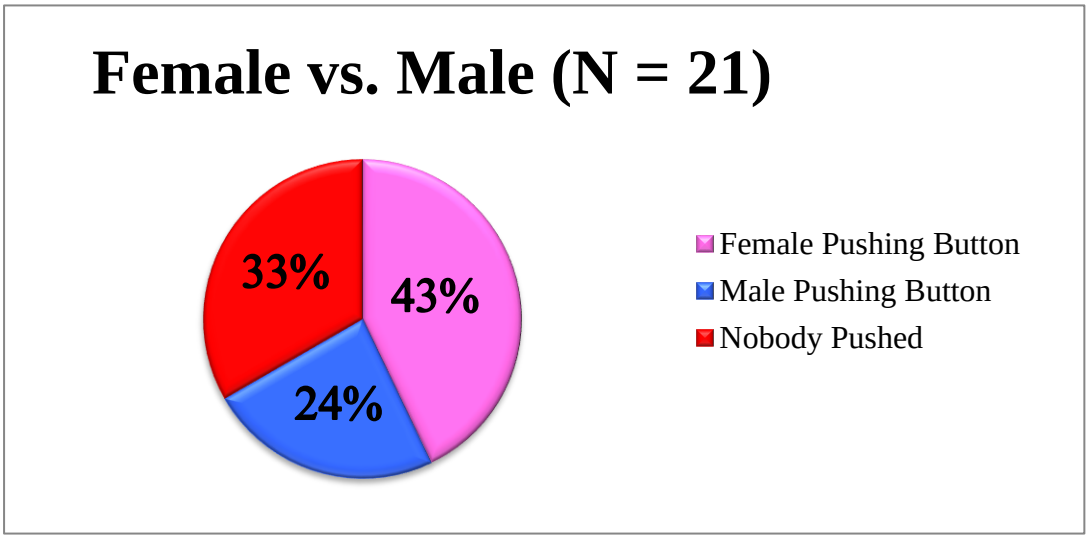
Table 4: Mean amounts pushed by males and females against both genders

Average amount pushed by a female		Average amount pushed by a male	
Against a female	Against a male	Against a female	Against a male
€ 38.581,25	€ 41.000,00	€ 37.810,00	€ 37.338,46

Notes: The averages were calculated by adding up all amounts pushed for each individual category and divided by the frequency in which this particular category occurred.

However looking at the "Female vs. Male" match-ups in image 6 it shows that relatively more females than males pushed the button. The main reason the women that pushed the button would give for pushing it prematurely is that they were afraid they would fall short if it had to come to solving a math problem. Of course education could also be a factor in this type of decision-making, taking into account that a career woman would most likely be up to the challenge of competing against a male in mathematics. In addition must be noted that also the percentage "Nobody Pushed" is higher than in cases of same gender match-ups, slightly rejecting the hypothesis that women are intimidated. This can also be related with the fact that the maximum amount limit was around €20.000 which is much lower than what women, or men, want to give up the opportunity to go to the final for. This aspect of gender, age and educational level as a factor in these type's of decision-making environments is maybe a good subject for further research.

Image 6: The Pct. (%) distribution of the semi-final with different gender match-ups



I am going to test if the contestants experience influence in behaviour from certain reference points in the course of the game. As discussed in the literature review the theory shows that once a reference point is established, for instance if the contestant has certain expectations of the outcome of the show or the contestant receives a high bank offer and declines it, two things can happen. First if the contestant opens up big suitcases, the contestant will receive a relatively low offer and will be less inclined to "Deal" unless the contestant plays his or her way back to the reference point with less regard of how much risk is taken. And secondly if gains are made in the round after the reference point was established, the contestant will become more risk averse in fear of falling below the reference point. Thus, risk seeking in the losses domain and risk aversion in the gains domain. Post et al (2008) found a similar pattern in their data calling it "path dependence". They divided the sample in three categories based on how well it was going for the contestants. The categories are "Loser", "Winner" and "Neutral". A contestant is classified a loser if their average of the remaining prize money after opening one extra case belongs to the bottom one third of the sample. In particular when the best possible case, with the lowest amount still in play, is opened. The average prize money in this best-case scenario (BC_r) is the following equation:

(1) $$BC_r = \frac{n_r \bar{x}_r - x_r^{\min}}{n_r - 1},$$

n_r is the number of cases remaining in the game rounds r = 1, 2, 3…9; $\bar{x}_r$ is the average prize money of the current round and x_r^{min} is the smallest prize left in play. This equation will be calculated for each contestant at the end of each of the 9 rounds. For each round the outcome is ranked and the lowest one-third will subsequently be put into the "loser" category. The same will be done for winners with a slightly different equation. In addition to the best-case scenario, the worst-case scenario is also calculated. In the worst-case equation the x_r^{min} will simply be replaced by x_r^{max}, which resembles the highest amount of prize money still in play. The equation for the worst-case scenario is the following:

(2) $$WC_r = \frac{n_r \bar{x}_r - x_r^{\max}}{n_r - 1}.$$

Again the score will be ranked and in this case the best one-third of the worst-case scores will be labeled as “Winners”. The third category will be labeled “Neutral”, this is for the cases that do not belong to either the “Winner” category or the “Loser” category. Table 3 shows the results per category, per game-round, that are generally in line with the results of Post et al 2008. If you look at the percentage “deal” average at the bottom you can see that contestants of the “Neutral” category are more likely to deal (28,8%) than the “Loser” (16,4%) and “Winner” (21,3%) category. Going in to the final, the contestant generally thinks he or she is going home with at least €100.000. Having this as reference point, contestants that are “Losers” will generally reject offers to try to restore the damage and try to still win a big prize. It has to relate to a certain reference point being that in most cases a “Loser” still gets offers with at least 4 zero’s up to high rounds, offers they would have signed for at the beginning of the episode way before they knew they would be in the final.

Table 5: Deal or No Deal decision-making grouped in categories

Round	**Loser**			**Neutral**			**Winner**		
	%BO	No.	%D	%BO	No.	%D	%BO	No.	%D
1	6,5	14	0	6,3	13	0	6,5	14	0
2	16	14	0	15,4	13	0	15,3	14	7,1
3	31,7	14	0	28,2	13	7,7	28,9	14	7,1
4	44,8	13	30,8	43,4	13	46,2	43,5	13	30,8
5	57,2	8	12,5	58,5	9	44,4	55	8	25
6	66,9	6	33,3	67,4	6	50	64,2	6	50

7		68,6	3	33,3		73,4	4	50		67,9	3	66,7
8		89,2	2	50		79,8	1	100		87,2	2	50
9		96	1	100		-	0	-		87,8	1	0
2-9			61	16,4			59	28,8			61	21,3

Notes: This table is an overview of the "Deal or No Deal" decisions made by the contestants of 41 episodes (N = 223) of 'Postcode Loterij Miljoenenjacht'. The contestants are categorized based on how well they are doing in the game, measured by equation 1 and 2. A contestant is labelled a "loser" if his or her average prize after opening one additional suitcase, containing the smallest amount still remaining, belongs to the worst one-third of all contestants in the current round. The contestant is labelled a "Winner" if his or her average prize after opening one additional suitcase, containing the biggest amount remaining, is among the best one-third of the contestants in the current round. It is possible for a contestant to be labelled a loser in the earlier rounds, sequentially have multiple rounds in which he or she opens better cases, to become labelled a winner in one of the later rounds. And finally a contestant is labelled "Neutral" if he or she does not belong to either the "Winner" or "Loser" category. For each of the three categories and nine game rounds the table illustrates the percentage bank offer ("%BO"), the number of contestants ("No") and the percentage of contestants electing to "Deal" ("%D").

But I do not necessarily think it is completely caused by the reference-dependence effect. Once contestants are doing well, not only will the audience get excited and start chanting for the contestant to keep on playing making it a decision under peer pressure, but he or she will start thinking about the upside potential. The opportunity that there could possibly be a grand prize in store that comes close or even surpasses a million. This million should be considered as a reference point. The act of declining an offer is also caused by the overvaluation of small probabilities. Thus the probability of being able to win a million or more. On top of that, not much is going wrong for a winner so why should he or she stop. Winners will keep on going until they hit a breaking point where something goes (slightly) wrong, meaning they will open big cases, after which they will either count their blessings and go again, or take home the provided offer. Both relying on what risk profile the contestant has. Also the BO%, which is the bank offer as a percentage of the remaining prize money, is larger for "losers" as it is for "winners". The neutral category's relative position of the BO% in relation with the other two categories varies and does not have a clear-cut pattern. But the main message concerning the bank offer is that it is derived from the expected value of the remaining price money and the contestant type. It should be considered an instrument to make the television show as entertaining as possible. In the case of the loser the offer tends to be more generous to keep the loser in the game. If it would

have been a regular offer the contestant would be faster inclined to “No deal”, whereas with a “generous” offer the contestant will put more thought and effort in the decision making the program more compelling and empathetic. A slightly different principle goes for the winners. If a contestant would win €5.000.000, besides the fact that it would not be very lucrative for the national lottery, it would make a very good episode to watch and increase the amount of views for the show. So when the show encounters a winner, the offer will be relatively low to incentivize the contestant to keep on playing hoping it will lead to even more exciting television. So in this perspective the offer is not an unbiased amount but an instrument to optimize the quality of the episode.

VI: Concluding remarks

This paper has a couple of main takeaways. First of all the probit regression showed a negative relationship between relative attractiveness of the bank offer and the likelihood that a contestant “Deals”. This means that if the expected value of the remaining price money is much higher than the bank offer the contestant is most likely not going to “Deal”. However, the regression showed no significance for age and gender. Meaning that it has no significant influence on the contestant’s decision. But my suspicions are that the semi final might play a role in this result. My theory is that the semi final acts as a sort of selection round. The individuals who are more risk averse opt out by pressing the button and receiving cash. So the contestants going to the final should have a more similar risk preference, thus making more similar “Deal” or “No Deal” decisions. I did not find any obvious differences between the average amount pushed by females or males against both genders. But I did find that when a man and a woman square off in the semi final the women pushed the button and opted out twice as much compared to males. This semi final angle, considering not only gender but also age, might be a good subject for further research. Secondly the data showed that contestants do in fact make decisions based on reference points. The data showed that “Losers” and “Winners” were less likely to deal compared to their “Neutral” counterparts. My theory for losers is that they have a certain expectation when participating in the final, based on having watched the show and having a certain amount in mind that is won on average. “Losers” will keep on playing until

they get back to this reference point or fail trying. However, in the realm of "Winners" I do not think the reference point is the main focus. If they are doing great and are considered "Winners" they are most likely going to be somewhere above the reference point, if not on the reference point being that it is likely to "re-set". The theory suggests that individuals are more risk-averse in that domain, so these individuals should be dealing more often which is not the case. My interpretation is that these contestants acknowledge that they are doing better than most participants in the same situation and start looking to the upside potential. These winners most likely have a few very high prices left in play and will seize this once in a lifetime moment to try and go for these life changing amount s of money. They are more frequently going to push their odds because they overweigh the small probability that they might have a million or more in their own case, making them less likely to deal as well. As for the bank offer, it starts out in the 6% category in round 1 and goes up to about 100% in the 9th round. It tends to be higher for people that deal than for people in the same round that do not deal. It also has the tendency to be higher for the "Losers" compared to the "Winners" in the same round. But one thing needs not to be forgotten. The bank offer is an instrument of the game show to manipulate and optimize the quality of the episode. For instance if the winner gets an relatively unfair offer he or she will be more inclined to go to the next round in pursuit of the big prices. In the case of the loser he or she will get a relatively fair offer as a sort of sympathy offer, which will cause for excitement when this offer is rejected because of certain reference points. The goal of the program directors is that the contestant keeps on playing, or to make the episode as exciting as possible. They want the contestant to think well about the decision he or she is going to make to increase the tension. In some way the decision making of the contestant is under control of the people behind the scenes of the show, and being guided in a certain direction.

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