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Measurement of the aversion towards risk through the use of the game "Ber nebo neber"

Bachelor's Thesis

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Prohlašuji na svou čest, že jsem bakalářskou práci vypracovala samostatně a s použitím uvedené literatury.

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Abstract

I explore the decision-making process of the contestats of the TV game show „Deal or no deal“ in Czech version „Ber nebo neber“. This decision-making process does not require any further skills or knowledge and it is based on the large stakes and deal or no deal decisions by accepting or rejecting possibility of continuing in the game. Based on the panel data set gathered from real played games, it is possible to determine the risk averse or risk seeking attitude of the contestants. The data set contains 28 episodes, 23 obtained directly from TV Prima and 5 of them from private sources, both between years 2007 and 2008. I assume the contestants under myopic and hyperopic framing and I find the average Arrow-Pratt coefficient of relative risk aversion (RRA). I consider different wealth levels and generally the RRA is lower for hyperopic framing. The differences in RRA may be most explained by the prior losses variable, which pictures the previous duration of the contestant's game.

JEL Classification:

C78, D81

Key words:

Risk aversion, Decision-making process, Arrow-Pratt relative risk aversion coefficient

Abstrakt

Tato práce zkoumá rozhodovací proces účastníků televizní soutěže „Ber nebo neber". Tento proces k dosažení rozhodnutí nevyžaduje žádné specifické dovednosti nebo znalosti a je založen na širokém spektru možných výher a rozhodnutích, zda-li pokračovat ve hře či ze hry odejít odmítnutím či přijetím bankéřovy nabídky. Je možné určit přístup hráčů k riziku. Z panelových dat získaných z jednotlivých skutečně odehraných dílu televizní soutěže lze zjistit, jestli je hráč averzní k riziku, nebo naopak riziko vyhledávající. Vzorek dat obsahuje celkem 28 dílů, kdy v každém z nich vystupuje jeden finalista. 23 dílů bylo získáno přímo z TV Prima a zbylých 5 pochází ze soukromého zdroje, všechny vysílány mezi lety 2007 a 2008. Uvažuji zde dva typy chování hráčů, hráče hyperopického a hráče myopického a nacházím průměrný Arrow-Pratt koeficient relativní averze k riziku (RRA). Také volím různé hladiny bohatství a na obecně vychází RRA nižší pro hyperopického hráče. Rozdíly v RRA mohou být nejlépe vysvětleny pomocí proměnné předešlých ztrát, která vyjadřuje předešlý průběh hry soutěžícího.

JEL Klasifikace:

C78, D81

Klíčová slova:

Averze k riziku, Rozhodovací proces, Arrow-Pratt koeficient relativní averze k riziku

Content

Introduction

Any decision we make bears a little risk. When it comes to life situations, our career or generally every decision we make, there are different possibilities which we have to consider and we take the risk of not choosing the right one. The decision-making process under the risk has long tradition and there are several theories dealing with this issue.

I got the inspiration of making this paper on example of Post, Baltussen and van den Assem, (2006), who put their brain to the study of measuring risk aversion on TV game show „Deal or No Deal“. Since the show was broadcasted also on Czech TV in Czech version under name „Ber nebo neber“ I made my sample based on the data from 28 episodes. Each contestant in the game deals with the decision-making process of taking the sure prize or continue under the risk to get his expected prize in the next round of the game.

I concentrate on measuring the Arrow-Pratt relative risk aversion (RRA) coefficient on the contestant's behavior to decide whether they are risk averse or risk seeking. On the multivariate regression analysis I try to find the most significant variable which interprets most of the model. After running the regression I found the variable prior losses to be the most significant and thanks to that also most able to interprete the model.

After watching all 28 epizodes I also fit the prospect theory by Kahneman and Tversky, 1979 to the contestant's behavior. It is observable that their reference point is set in most of the cases to zero and they do not consider the bank-offer (accepting the sure prize) as their own wealth. That makes the contestants with this way of thinking to be more risk seeking by comparing their situation to the one when the game started. In other words they see themselves in better situation after the whole game even if their win would equal to 1 CZK.

In the first part of my paper, I concentrate on the theory and especially on the description of the game show. Furthermore I comment on the data I obtained from TV Prima. In the next part I choose the methodology which I pick on the example of Post, Baltussen and van den Assem, 2006 and use the same one as far as the dataset and the game rules are suitable to their ones. This part is followed by commenting on the prospect theory and then the actual results.

Decision under risk

If we need to make the decision between choices, we compare different expected values to make the final dicision. Sometimes comparing expected values is enough, in case of having just small stakes at risk. In most cases this is appliable. On the other hand if the stake at risk is high, that is not appropriate anymore. If the dicision is made under risk, the expected values will be different than the values for risky alternative because of the loss probability.

The certainty equivalent

„The certainty equivalent for an alternative is the certain amount that is equally preferred to the alternative. An equivalent term for certainty equivalent is selling price.“[1]

The decision makers are divided according to their certainty equivalent. If their certainty equivalent is lower than their expected value, they are considered as risk averse. If the certainty equivalent equals the expected value, the decision maker is risk neutral. On the other hand, if the certainty equivalent is higher, it means the decision maker is risk seeking. In other words the decision maker is considered as risk averse, if his certainty equivalent is higher than the expected loss and vice versa.[2] In this paper I try to differ between the risk averse and risk seeking decision makers and find what influences the attitude towards risk the most.

Description of the game show

The first episode of the game show „Deal or No Deal“ broadcasted under Czech name „Ber nebo neber“ appeared on television in the Czech Republic on February 11th 2007. We can find the origin of the show in Netherlands though, where it was developed by the Dutch company Endemol and first on the air in 2002[3]. Thanks to the huge ratings the show was lately exported not just into other European countries but also overseas, for instance Post, Baltussen and Van den Assen, (2006). TV Prima got the license for broadcasting „Deal or No Deal“ from license from Endemol International, which is the world's largest independent production company, which consists of over 80 companies over 31 countries and this game show was produced in 66 territories all over the world.[4]

There are always three contestants in each round. The contestants are chosen to the show based on the previous casting. At the beginning of each round there will be those three contestants fighting for the finalist position. They are chosen based on the elimination game, which includes knowledge questions, to the final game, which is played just by one finalist. The main task in the elimination game is to be bright and fast – who answers first wins and continues straight to the final game. If the answer is not correct, the contestant is out of the game and the two other continue.

1 Kirkwood, C. W. : Decision Tree Primer, 2002.
2 Wu, G, Zhang, J., Gonzales, R.: Decision under risk, 2004.
3 Post, T., Baltussen, G., Van den Assem, M.: Deal or No Deal? Decision-making under Risk in a Large Payoff Game Show, Tinbergen Institute, 2006.
4 http://www.endemol.com

Each episode in our sample consists of two different games – the elimination game and main „Deal or no deal“game. This paper concetrates on the second part. The first could tell us just more about the characteristics of the players.

The finalist is asked to choose one of 26 briefcases and the one will be laid by the moderator. Each of those 26 briefcases contains hidden amount of money. The range of the amounts is different from state to state. There are amounts from 1 CZK to 5,000,000 million CZK in the Czech version, which shows us the huge range. The distribution of the prizes in the briefcases is the same for each episode and the contestants are informed about that. To illustrate how the main screen looks like, there is Figue I at the end of the paper. One mentioned briefcase will be opened at the end of the game.

There is also a „banker“ in the game. His task is to make the contestant sell the first briefcase after each round. The maximum possible number of rounds is nine. The first round the finalist opens 6 other briefcases out of 25 briefcases left. By opening the briefcases the contestants can get the probability of the amount in his first briefcase and so does the banker's offers correspond to the probability in having big or small amount in the original briefcase, so the uncertainty disappears. More eliminated briefcases give the contestant better estimation of what prize may remain in the original briefcase.

The „bank offer“ made after each round is based on the remaining briefcases. After the first round it will be made based on 20 amounts left in the game. The finalist has two options after each round – he can accept the offer by saying „Deal“ or he can refuse by „No Deal“ and he continues by entering next round. If he accepts, he will walk away with the bankers offer.

If he continues, the game looks as follows – he opens 5 briefcases in the second round, after not accepting another offer he opens 4 briefcases, and he can continue by not accepting the offer by selecting another 3, 2, 1, 1, 1 and 1. If he gets to the last round, there are just two briefcases left and he could accept the banker's offer or he could pick from the two last briefcases.

The bank offers change from round to round and there is no certainty that the offer will be higher after the next round. The offer always depends on eliminated briefcases and remaining prizes in the game, so the bank offer is not predictable. When more briefcases with low prizes are opened, more generous the banker is and vice versa. If all high-priced briefcases are opened, so as the banker's offers differ and the offer is always connected with the highest remaining price. The offers also differ from round to round as the probabilities change. The banker starts with quite low offers and he rises them gradually. This move is quite logical from the banker's point of view, since the banker wants to make the contestant stay in the game, so as the enthusiasm and attitude changes with more attractive offers for the contestants.

Data

Since game show Deal or no deal was broadcasted in 66 teritorries, most of the teritorries adapted the official name to the language of their country. The Czech version of the game show was „Ber nebo neber“ and it showed up on TV on 11th February 2007 for the first time. It was broadcasted for almost two years between 2007 and 2008. Since February 2007 the game started to be the part of the prime time, Sunday evening.

In this study I got the access to 23 broadcasted shows directly from the record office of TV Prima and 5 epizodes from private sources. The game show is not on air since 2008, there were no video records available online and the rest of the shows are forbidden to be provided to third person from the official source. Thanks to these consequences I will be working just with the sample of 28 games and consider the size of the sample. These 28 episodes were on air in both years 2007 and 2008. Between these two years the game was not changed and the rules and the prizes were remained.

The sample has the advantages of not changing the rules and prizes, so we can compare the risk aversion. On the other side the three finalists in the pre game are not chosen randomly, but strictly by the producer. Since the production team does not work for TV Prima any longer, I did not manage to find out the rules for their selection. There is also the fact, that the 23 games in the sample were broadcasted from the 69th edition and up, so the contestants could have had an experience from watching the show on TV and getting more rational, then the contastents at the beginning of the broadcast. On the other side the 5 other epizodes are from the very beginning when the game showed up on air.

I collect the data directly from every round of every episode and I concentrate on collecting every amount the contestant eliminated by choosing the briefcase and also all the remaining prizes in not chosen briefcases, then the offer of the banker and the dicision taking or not taking the offer made by the contestant after each round. Afterwards the data is ordered into a panel data set with a time series dimension (the game rounds) and a cross-section dimension (contestants).[5]

I also collect information of every contestant to compare the risk aversion depanding on age, sex and education. This type of information is mentioned at the beginning of the final round when the contestant is introducing himself on task of the host. Not all of the contestants mention their age, so I fill the missing data by using estimated age based on appearence. I do the same procedure on education based on working position.[6]

Comparing the sample of 28 rounds, 57 % are male contestants. Considering the size of the sample, I cannot acknowledge that male contestants are more likely to get to the final game. As

5 Post, T., Baltussen, G., Van den Assem, M.: Deal or No Deal? Decision-making under Risk in a Large Payoff Game Show, Tinbergen Institute, 2006.

6 After making the opinion I have compared the estimated age and education with two other students.

already mentioned, the semifinalists are selected by the producer and in some semifinals there are just female semifinalists and vice versa. Most of the participants have high school or mentor school, about one third has at least a bachelor degree and the average age of contestants in my sample is about 41. Another observed variable is the amount people walk out with after they made the deal. The average win is over 250,000 CZK and the end of the game usually comes after seventh round, just two rounds before opening the last briefcase. Over 20% of the sample finishes by taking the risk and open the original briefcase they picked at the beginning of the final game.

Taking the values above I can say that the difference between the sexes is not too obvious. That could be influenced by the producer selection through who is in charge of choosing semifinalist to the elimination game. The questions in the elimination games are from different knowledge fields. I find most of the questions from the culture, theatre, sport and media, not that oriented in intelligence though. The probability of winning is not that influenced by highest education achieved.

Descriptive statistics

The table below represents the summary statistics of my sample collected on game Deal or no deal in Czech version Ber nebo neber. The data was collected from the records obtained by TV Prima and the episodes were on air between years 2007 and 2008. These descriptive statistics are made on the basis of the facts observable from the game. Some of the information especially age and education are estimated from the introduction interview with the finalist and physical appearance.

I use dummy variables representing sex and education. 1 stands for females, 0 for men and 1 for higher than high school education and 0 for high school education. The age is represented in years. The stop round is the number of round when the contestant decides to finish his game by accepting the bank-offer. If he gets to round number 9, it means he rejects the last offer and decides to open the original briefcase. That means number 9 represents the player who gets to opening the original briefcase and stays in the game till the end. All the prizes are in CZE.

Table I.

Summary Statistics, using the observations 1 - 29
(missing values were skipped)

Variable	Mean	Std. Dev.	Minimum	Maximum
Age	41.3333	14.6969	22.0000	65.0000
Gender	0.428571	0.503953	0.000000	1.00000
Education	0.375000	0.494535	0.000000	1.00000
Stop_round	7.32143	1.15642	5.00000	9.00000
Prize_won	254903.	242250.	20.0000	930000.

Methodology

As the main resource in this part I use the study by Post, Baltussen and van den Assem, (2006) from several reasons. They gave me the inspiration and the main thought of how to work with the data, since having the same type of data and same rules of the game. I also use some of their thoughts and results to compare and examine them with the results on Czech data. I use the two-stage methodology based on their paper and I also use their indication. The description of the game and main principle is the same as mentioned above, so as the logic of making dicisions. Furthermore I use also prospect theory, which I find obvious from the process of the game. In the first stage, I estimate, as in the original paper, the Arrow-Pratt relative risk aversion (RRA), which is made for every contestant for every round.

Arrow-Pratt measures of risk aversion

Arrow (1971) and Pratt (1964) have developed the theory of risk aversion so as the application of the measures to risky situations through the application of risk aversion measures.[7] They came up with two different risk aversion measures – an absolute (ARA) and relative (RRA) one. There is no unique definition of expected utility functions, when it comes to their transformations, therefore it is needed to find the measurement, which would stay constant even though the transformations come up. One of the measurement is ARA. I use RRA in my study, which is able to capture the changes in utility functions from risk averse attitude to risk seeking attitude and still being considered as the actual measurement of risk aversion.

7 Levy, H., Levy, A.: Arrow-Pratt measures of risk aversion: The multivariate case. International Economic Review, Vol. 32, No. 4 (Nov., 1991), pp. 891-898.

Stage 1: RRA Estimation

By using time series, which includes the contestant's decision of taking or leaving the bank offer in each round, I get the lower and upper bounds of each contestant's RRA. Since every contestant is different, so are his decisions made in each round. What I find for each contestant is the unique RRA coefficient, that explains the situation where the contestant is indifferent between taking or leaving the offer. In each round I find different RRA, which interpretes that the contestant is risk averse if the value in the round is higher than the unique RRA coefficient (it means the player accept the offer and the game ends), on the other hand the contestant is risk seeking, if his RRA is less than 0.

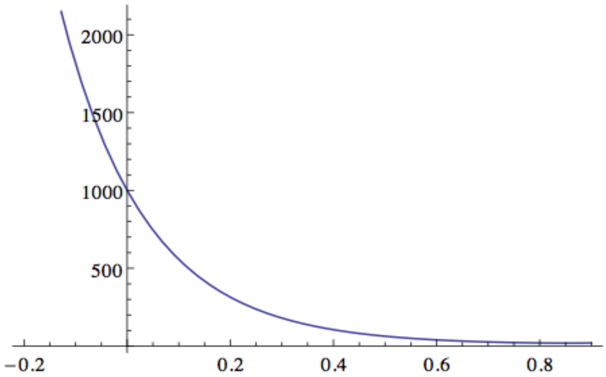
The index for each contestant is noted as *i* and it goes from 1 to 28, because of having the sample of 28 contestants in 28 games. Since different contestant finishes in different round and I need RRA from each of these rounds, *r* stands for notation of the number of round, which goes from 1 to 10. If $r = 10$, it means the contestant does not accept any of the bank offer and opens the original selected briefcase. *R* represents just the number of the final round. *W* stands for the contenstants initial wealth which is affected by his possesions and income. By eliminating the briefcases in each round, important is to know the remaing prizes in the game, which is hidden under x_r and also the number of briefcases left in the game n_r. Given $r = 1,...,9$, x_{r+1} is a subset of n_{r+1} elements of x_r. The collection of all subsets is denoted by $X(x_r)$.[8] γ stands for the RRA coefficient. Individual preferences are found by using the CRRA utility function (Post, Baltussen and van den Assem, 2006):

$$u(x|\gamma,W) \equiv \frac{(x+W)^{1-\gamma}}{1-\gamma} \tag{1}$$

I show how the utility function works on example. Let's assume that the initial wealth $W = 0$ and $\gamma = -0.2$ to 0.9 and $x = 1000$. The graph of the utility function will look as follow:

8 Post, T., Baltussen, G., Van den Assem, M. (2006), p.6

Figure II.



There are the values of γ on the horizontal axis and the remaining prizes on the vertical one. If his $\gamma = 0$, he is not risk averse, not even risk seeking and his expected utility fits the value of remaining prizes, 1000 in this case. On the other hand if his $\gamma > 0$, the utility from remaining prizes decreases and he is more risk averse and less willing to continue with the game, which bears too high uncertainity for them that they can't accept. If $\gamma < 0$, it represents the risk seeking individuals whose utility from continuing the game is even higher than the remaining prizes.

The function of the remaining prizes x_r is expressed as a bank-offer b_x.

I use:

$$\hat{\gamma}_{i,r}(W,b) \equiv \left\{ \gamma : g(x_{i,r},\gamma,W,b) = u(b(x_{i,r})|\gamma,W) \right\} \tag{2}$$

to compute the critical RRA value, which is the value where the contestant is indiffernt whether he decides to accept or reject the offer made by the banker. This critical value is computed for each player i and each game round r. The critical RRA value represents that value of risk aversion, where the utility from continuing and utility from taking the bank-offer is the same. There is the g function, which expresses the utility of the players who decide not to take the bank-offer. It is not an exact value. $x_{i,r}$ stands for the function of the banker.

Let's assume that the banker offers 100 000 CZK and the utility of the player is 80 000 CZK.[9] If the contestant's gamma equals 0, he compares these two values. On the example, he would take the offer. Function g decreases faster. As the contestant is more risk averse, his expected utility rises. The utility increses until the value equals the value of the bank-offer. In that moment the contestant is indifferent between taking the offer and continuing to the next round. That is the situation where the critical RRA arises.

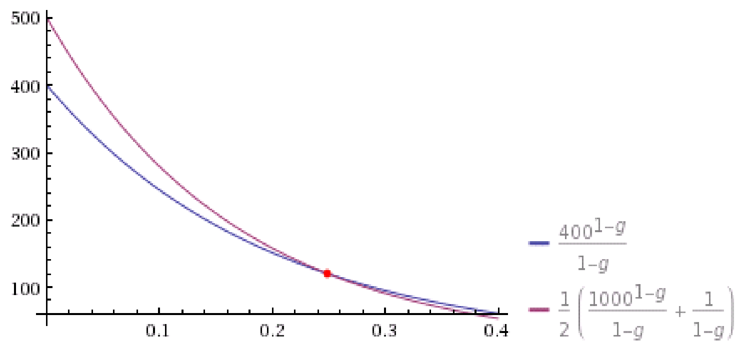
Generally, if the contestant is risk averse and decides not to continue with the game, he

9 The utility of the player, who takes the deal, is expressed on the right part of the equation.

compares the certainty equivalent and the bank-offer and the certainty equivalent must be lower than the offer. Which is the same situation as earlier, his RRA in this round is higher than the value of unique RRA coefficient. If his RRA is lower than this value, that means his certainty equivalent must be on the other hand higher than the bank-offer.

Let's have another example showing on the graph, how the critical RRA is counted. This graph shows the utility of the contestant from taking the offer and not taking the offer. I assume the player under hyperopic framing[10] in his last round, considering two last briefcases. There are two prizes – 1 CZK and 1 000 CZK. The bank-offer for this round is 400 CZK. If he decides for not taking the offer, he gets one of the last briefcases. On the other hand he gets the bank-offer.

Figure III.



The purple curve represents *g* function (the utility of continuing) and the blue on the other hand the utility of taking the offer. The interception of these two curves is marked by red point and it represents the critical RRA.

In the first case of being risk averse, the value of unique RRA coefficient for the last round *R* yields to make up the lower bounds to the RRA of the contestant. If the contestant goes to the very last round possible, in other words he opens the original briefcase, the lower bound is indeterminable. The interpretation of the lower bound looks as follow:

$$\hat{y}_i^{L}(W,b) \equiv \hat{\gamma}_{i,R}(W,b) \tag{3}$$

The equation determines the lower bound which arises, when the contestant accepts the bank-offer. If the contestant takes the offer, his aversion is higher than his critical RRA. That means his lower bound equals his idifferent gamma.

For example, the contestant is in his first round. He eliminated 6 briefcases and the banker

10 The contestants under hyperopic framing have specific decision-making process which is explained deeper on p.17.

made an offer. I assume knowing his critical RRA. If he does not take the offer, that means his aversion towards risk is lower than the critical RRA. If he takes the offer, that means his aversion towards risk is higher than the critical RRA and I can set his lower bound.

The interpretation of the upper bound to the contestant's RRA looks as follow:

$$\hat{y}_i^{\mathrm{U}}(W,b) \equiv \min_{r=1,\ldots,R-1}(\hat{y}_{i,r}(W,b)) \tag{4}$$

The contestant's RRA in each round where he decides to continue is lower than the critical RRA. That applies for each round finished by the decision no deal. His RRA is always bounded by the critical RRA in each round. I consider every round and take all critical RRA values. The minimum one expresses, how far the person is willing to continue regarding risk.

As Post, Baltussen and van den Assem, (2006) I use the arithmetic average of those two upper and lower bounds to estimate the RRA coefficient:[11]

$$\bar{\hat{\gamma}}_i(W,b) \equiv \tfrac{1}{2}(\hat{\gamma}_i^{\mathrm{L}}(W,b) + \hat{\gamma}_i^{\mathrm{U}}(W,b)) \tag{5}$$

Now I know the upper and lower bound for every contestant and I know there is their RRA inside of the subrange. For not having to work with the subrange, I set the mean of these two values, which is the best representative of the subrange.

As Post, Baltussen and van den Assem, (2006) worked on their paper, they had to consider the level of initial wealth of the contestants while computing their RRA. They used the median household income. The initial wealth of the contestant can have big influence on the decision-making process and some of the contestants can seem risk seeking just because of being in different life situation as the other ones. Unfortunatelly there is no data on the contestant's welfare, as the personal data is taken exactly from the game show. Post, Baltussen and van den Assem, 2006 used the median household income for Netherlands and Australia. I use three different levels of welfare set to 0 CZK, 8 000 CZK and 25 000 CZK to compare how different the attitude towards risk is.

The banker's behavior is specific in some features. His offers are relatively low to make the contestant stay in the game for further rounds. As the game progresses the banker is more generous and on the other hand he increases the offer as the percentage of the expected prize in higher rounds. Higher the expected offer is, higher RRA the contestant needs to make the dicision about leaving the game and taking the offer. Another specific feature of banker's behavior appears when

11 Post, T., Baltussen, G., Van den Assem, M., (2006), p. 7.

he is quite generous also after eliminating more valuable briefcases. It is obvious from the data, that the bank-offer is influenced mostly by the gamer round *r* and the remaining prizes *x*. Post, Baltussen and van dem Assem used the two-parameter model to quantify the behavior of the banker[12]:

$$E[b(x_{i,r})] = E(x_{10} | x_{i,r}) \times (1 - \exp(\alpha_0 r^2)) \times \exp(\alpha_1 (for_{i,r}^{-1} - 1)) \qquad (6)$$

This equation expresses how the banker values a given situation. The mean value E presents the average value of the briefcases. His offer flows around this average value of the briefcase. It is not the only influence though. The banker also takes into account the number of the round and their situation, in other words how well the previous rounds went. The second and third part of the equation were made by Post, Baltussen and Van den Assem, (2006) and I use it too. The function rises with higher round. for_r stands for the succes during the game.[13]

The bank-offers flow from 0 to the expected prize in the neutral situation ($for_{i,r} = 1$) if $\alpha_0 \leq 0$ and a „bonus“ is given to the unfortunate contestants ($for_{i,r} << 1$) if $\alpha_1 \geq 0$.[14]

Using the example I find two parameters – α_0 and α_1. These are found for all players in each rounds using the method of minimazing the sum of squared errors. For example, I take one round and I establish all the values to the equation. I find out what bank offer the banker should make and I have the actual bank offer he made from the data. I try to approximate the values to set the α_0 and α_1. The parameters are found under myopic framing[15] and there are different values because of using different wealth levels. For zero wealth level $\hat{\alpha}_0$ = - 0,02 and $\hat{\alpha}_1$ = 0,00028. The *R-squared* for this model equals 86 % so it represents pretty good fit. Those values are suitable to the duration of the episodes, because of incresing the offer (%) in further rounds and also in the situation of big losses. I find the function matching banker's evaluation for given situation.

The biggest influence on the bank-offer and making the decision-making process has the remaining prizes in the game. If there are still huge amounts in the game, the contestant feels the confidence and also his expectation about the bank-offer is high. The show was on air for two years, that way it is more than predictable that the contestants have some ability to estimate the bank-offers after watching the show regularly. There may be observable the disadvantage of the players in the first episodes. They had obviously more uncertainty when it came to estimation of the offer.

12 Post, T., Baltussen, G., Van den Assem, M., (2006), p. 8.
13 Further details and calculation of for variable is shown in section „Regression analysis“
14 *Ibid*., p. 8-9.
15 I consider two types of contestants in my paper. One type decides under myopic framing and the other one under hyperopic framing. Both types are discussed later.

I consider in my study two types of contestants. Contestants with myopic frame and with hyperopic frame. In the mentioned study by Post, Baltussen and van dem Assem, (2006), they work mainly with the rational player, who has different way of thinking. The rational contestant compares all situations, not just the situation he is in right now. In other words, he does not make decision of accepting or rejecting just for the actual round, but he also thinks about the future round. This process is quite complicated so I use the two mentioned frames above. The contestant with hyperopic frame is the one who concentrates just on the original briefcase he picked at the beginning of the final game and ignores the offers in each round. In other words he does not take the Deal option in any round and continues to the last round to open the original briefcase. Because of that the expected utility function relates to a No deal decision:

$$g(x_r, \gamma, W, b) \equiv \sum_{k=1}^{n_r} u(x_{r,k}) \times n_r^{-1} \tag{7}$$

In other words, the contestant under hyperopic framing thinks over the original briefcase. That way I compute the utility function for each briefcase remaining in the game and by computing the average of these utility functions I get the average utility for the contestant under hyperopic framing in the last round.

Myopic frame is a little bit more complicated, since the player is willing to accept the bank offer in certain conditions. He is not as rational as the very first case of the contestant who considers each future round, but he focuses just on the offer in the next round and does not consider the possibility of rejecting the offer in the future round and possibility of continuing. The expected utility of a No deal for this frame looks as follow:[16]

$$g(x_r, \gamma, W, b) \equiv \sum_{y \in X(x_r)} u(b(y) | \gamma, W) \times \binom{n_r}{n_{r+1}}^{-1} \tag{8}$$

The contestant considers the future bank-offer in the next round. He takes all possibilities of briefcases, which he can eliminate in the future round and that is the reason for binomial coefficient in this equation. He takes every possible combination of elimination and computes the expected bank-offer in the next round after the elimination. Therefore I consider also the bank-offer. From the future bank-offers for each combination the contestant makes the utility and afterwards makes the average. Let's assume the contestant has 20 briefcases left ($n_r = 20$) . He is supposed to

16 Post, T., Baltussen, G., Van den Assem, M., (2006), p. 9.

eliminate 5 in the next round (n_{r+1} = 15). The banker values that 15 briefcases.

Stage 2: Regression analysis

In the second stage I get the inspiration of Post, Baltussen and van dem Assem, 2006 and try to predict different values of RRA. Having RRA for each contestant in each round they used multivariate regression analysis to explain the cross-sectional variation in the estimates. To run this regression they used three different attributes – the contestant's characteristics (to do that I use variables, which I get from the other data set, which collects the characteristic information on the sample), information about previous gains and losses and shape of the distribution.[17]

Characteristics of the contestants

The contestant's characteristics are presented during the whole game. The contestant is asked to introduce himself at the very beginning of the final game, but there is no strict criteria of what exactly to say. Some of the contestants mention all necessary information, on the other hand there are some, who I need to use my own judgement on filling the missing data. The sex of the contestants is obvious. I use my own judgement especially in filling up age and education.[18] To estimate the age I use the physical appearance and also the age of the children or other notes the contestants mention during the game as how long they work in the same job etc. The contestants rarely mention their education obtained. I differ the high school education (low) and higher one (high) and in the missing data I estimate it by using their working position. It is much easier to fill the education if the contestant is a university student. I use the variables as regressors in the multivariate analysis:

- Sex (female/male)
- Age (years)
- Education (low/high).

In the original study they consider also the family members or friends who sit in the audience during the game and whose task is to help the finalist during the decision-making process. On the data I use, it rarely happens that the contestant changes his decision under the pressure of its „help“. As they consider this influence, they should also use the pressure made by the audience by itself. The audience in each round and each game tries to make the contestant reject the offer and

17 Post, T., Baltussen, G., Van den Assem, M., (2006), p. 9-10.
18 As mentioned earlier, after making my own opinion I have compared the estimated age and education with two other students.

continue with the game. The audience is obviously under no risk and purely enjoys the feeling of adrenalin. Some of the contestants can be also influenced by that effect, some of them might also enjoy the feeling of being on television.[19]

Previous gains and losses

I get the inspiration of taking the values of previous gains and losses on the example by Post, Baltussen and van den Assem, 2006. They measure the fortune experienced from the epizode as the ratio of current expected prize and initial expected prize. So as the RRA is the result of averaging lower and upper bounds from the rounds, they get the average of the values of fortune in the same two rounds. They name the final variable for_i.

To get the final variable for_i I divide the expected values of briefcases remaining in the game by the expected value of all briefcases at the beginning of the final game. At the beginning the average value of briefcases is 423 706 CZK. As the contestants eliminate the briefcases, the value of remaing briefcases changes. If the average value of remaining briefcases is lower than the original one in the first round, the game is not going well and $for_i \leq 1$. On the other hand, if the average value of remaining briefcases is higher, the contestant is in good situation and $for_i > 1$. To make variables prior gains and prior losses I subtract 1 and if the result is higher than 0, it is good situation and if it is lower than 0, it is bad situation. This value is possible to use, but Post, Baltussen and Van den Assem make the dummy variable to distinguish between reactions to gains and reactions to losses. If people are in good situation ($for_i > 1$), the variable prior gains is active and prior losses is nonactive and equals to zero and vice versa.

I take them as the example and as the regressors use:

- Prior losses: $(for_i - 1) * loss_i$,if the contestant is in good situation ($for_i > 1$), this variable equals to 0, otherwise it gets negative values.
- Prior gains: $(for_i - 1) * gain_i$,if the contestant is in bad situation ($for_i \leq 1$), this variable equals to 0, otherwise it get positive values.

These regressors are exogenous, in other words the prior losses and gains can influence the risk aversion, but it doe not work the other way round.[20]

19 Beetsma, R. M. W. J., Schotman, P. C.: Measuring risk attitudes in a natural experiment: Data from the television game show Lingo, The Economic Journal, Vol. 111, No. 474 (Oct., 2001), pp. 821-848.
20 Post, T., Baltussen, G., Van den Assem, M., (2006), p. 10.

Results

Stage 1: RRA Estimates

I compute the Arrow-Pratt relative risk aversion, RRA, for each contestant and each round. The sample consists of 28 contestants who were part of the game between years 2007 and 2008 in the Czech Republic. I also consider different wealth of the contestants. Since there is no way to find out the financial situation of each player, at first I consider their wealth as zero, then the minimum wage 8 000 CZK and at last the average prize 25 000 CZK. Through that it is observable that the wealth level influences the risk aversion. People with higher income will be more risk seeking in some situations. The most important values are the mean, minimum, maximum and standard deviation and all of them are captured for the lower bound, upper bound and the average, which is marked as RRA.

I study two types of contestants. The first type is the contestant with hyperopic frame in panel A and the second one is the contestant with myopic frame in panel B. The hyperopic frame stands for the contestants who ignores the the bank offer in the intermediate rounds and concentrates just on the prize in the original briefcase they picked at the beginning of the final game. Contestants under myoping framing consider the bank offer in the next round and ignores the possibility that they could reject the future offer and continues to the next round.

Table II.

A.

GAMMA BOUNDS "Hyperopic frame" W = 0 CZK

Summary Statistics, using the observations 1 - 28

Variable	Mean	Std. Dev.	Minimum	Maximum
lowerBound	0.244017	0.163549	0.000000	0.742112
upperBound	0.292374	0.214338	-0.261680	0.626270
RRA	0.275611	0.168077	0.000000	0.681423

GAMMA BOUNDS "Hyperopic frame" W = 8000 CZK

Summary Statistics, using the observations 1 - 28

Variable	Mean	Std. Dev.	Minimum	Maximum
lowerBound	0.294954	0.245438	0.000000	1.15078
upperBound	0.358044	0.184051	-0.0111342	0.686053
RRA	0.318873	0.204831	0.000000	0.779239

GAMMA BOUNDS “Hyperopic frame” W = 25000 CZK

Summary Statistics, using the observations 1 - 28

Variable	Mean	Std. Dev.	Minimum	Maximum
lowerBound	0.286029	0.208879	0.000000	0.945150
upperBound	0.405547	0.204430	-0.00891869	0.755183
RRA	0.327360	0.214196	0.000000	0.850167

B.

GAMMA BOUNDS “Myopic frame” W = 0 CZK

Summary Statistics, using the observations 1 - 28

Variable	Mean	Std. Dev.	Minimum	Maximum
lowerBound	0.311787	0.384188	-0.00933179	1.19840
upperBound	0.646892	0.711512	-0.154311	2.25610
RRA	0.435361	0.489361	-0.0107681	1.58741

GAMMA BOUNDS “Myopic frame” W = 8000 CZK

Summary Statistics, using the observations 1 - 28

Variable	Mean	Std. Dev.	Minimum	Maximum
lowerBound	0.373115	0.483882	-0.00901528	1.83577
upperBound	0.738580	0.787633	-0.0670777	2.81395
RRA	0.498239	0.532479	-0.0103593	1.64761

GAMMA BOUNDS “Myopic frame” W = 25000 CZK

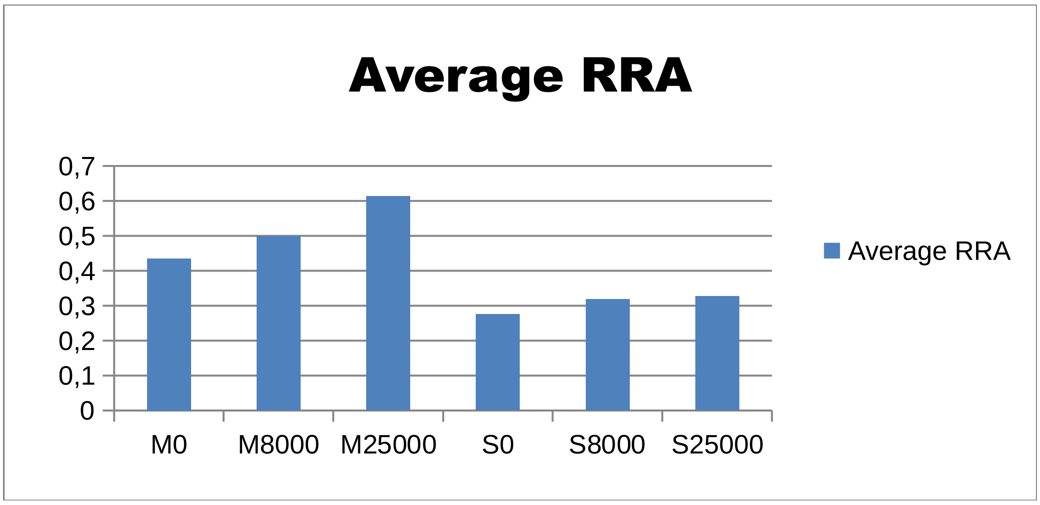
Summary Statistics, using the observations 1 - 28

Variable	Mean	Std. Dev.	Minimum	Maximum
lowerBound	0.493897	0.830009	-0.00839953	4.15026
upperBound	0.885479	0.932692	-0.0458563	3.64688
RRA	0.613344	0.676599	-0.00957856	2.49869

The results of the RRA estimates are expressed by the table II. I examine the values on three different wealth levels. The first table always represents zero value of wealth, the second 8 000 CZK and the third one 25 000 CZK. The level of wealth influences the RRA values for both hyperopic and myopic framing significantly. Contestants with the higher wealth are more risk seeking as an exception in those situations, where the bank-offers are low, when they ignore understandable and sometimes favourable bank-offers just because of way of thinking and their value of wealth. In other words they compare the value of wealth they had before they came to the game and the offer made by the banker. Low offers are not motivational enough for them. Generally people with higher level of wealth are more risk averse.

By looking at the results it is more than observable that the contestants under myopic framing are more risk averse (maximum value of RRA considering wealth value of 25 000 CZK is higher than 2) than the contestants under hyperopic framing who are more risk seeking (maximum value of RRA considering wealth value of 25 000 CZK is under 1). On the other hand the minimum values of RRA making the contestans risk seeking are less than 0.

Figure IV.



The graph above shows the differences in average RRA influenced by different framing and different wealth level. M stands for myopic framing and S for hyperopic framing. The numbers explain the wealth level of contestants. As discussed above, it is observable that contestants under myopic framing are generally more risk averse, because of considering their possible situations in their next round. The differences in attitude towards risk are also observable. Higher wealth level of the contestant, more risk averse he is.

Comparing the results for two different types of framing, the contestants under myopic framing are more rational than the contestants under hyperopic framing who overestimate their dicisions by ignoring the bank-offers and concentrating on the original briefcase. Contestants under myopic framing are not fully rational either but they consider the bank-offer for the next round and that makes them more risk averse, which is observable from the higher values of RRA in the results.

I also find in the results situations where the lower bound obtains lower values than upper bound. This special situation may be caused by changing the contastant's attitude towards risk in different rounds of the same game or they are not able to satisfyingly evaluate the situation.

Stage 2: Regression

In this part I comment on the multivariate regression analysis which explains the cross-sectional differences in RRA. I use the OLS regression on the model under myopic framing with different wealth levels and all regressors. The results are commented on the basis of Table III. I run the regression analysis on the data and the results are observable Table III. below. The regression is made on the sample of 28 episodes of the game show „Ber nebo neber“ with the official name „Deal or no deal“. The data is collected from the records obtained from Prima TV. The official episodes were on air between years 2007 and 2008. RRA was set as the dependent variable with all levels of wealth, so there are three results below. I used the myopic framing for this regression. Under myopic framing the contestant has in mind the bank-offer for the next round (using the distribution of this offer). I use three different wealth levels and I comment on the model with the wealth level zero, to explain the results brought by the regression analysis.

Table III.
W=0

Model 1: OLS, using observations 1-28 (n = 17)
Missing or incomplete observations dropped: 11
Dependent variable: RRA

	Coefficient	*Std. Error*	*p-value*	
const	1.01778	0.546983	0.08971	*
age	-0.000559065	0.00826717	0.94730	
gender	-0.171883	0.228465	0.46764	
education	-0.302348	0.257125	0.26447	
prior_gains	0.164403	0.262804	0.54436	
prior_losses	0.724484	0.406596	0.10237	
R-squared				0.471825

W=8000

Model 1: OLS, using observations 1-28 (n = 17)
Missing or incomplete observations dropped: 11
Dependent variable: RRA

	Coefficient	*Std. Error*	*p-value*	
const	1.04664	0.664848	0.14373	
age	- 0.000579155	0.0100589	0.95512	
gender	-0.240881	0.27767	0.40419	
education	-0.215928	0.312364	0.50372	
priorGain	0.18709	0.31971	0.57023	
priorLoss	0.539919	0.499619	0.30297	
R-squared				0.290038

W=25000

Model 1: OLS, using observations 1-28 (n = 17)
Missing or incomplete observations dropped: 11
Dependent variable: RRA

	Coefficient	*Std. Error*	*p-value*
const	1.01716	0.968659	0.31621
age	0.000175712	0.0146554	0.99065
gender	-0.349827	0.404555	0.40566
education	-0.0396985	0.455103	0.93206
priorGain	0.259966	0.465805	0.58795
priorLoss	0.108684	0.727927	0.88401

R-squared 0.102673

Gender and education are the dummy variables, 0 for male, 1 for female, analagously 0 for high school education and 1 for higher education.

Non of the variables is significant except for the constant (on 90 % confidence level). The most significant variable from the model is for prior_losses, so it explains the most of the model. By having the positive sign it is observable that the RRA is the reason for decreasing next losses. In other words the coefficient explains the risk seeking attitude of the contestants after eliminating the high values briefcases from the game, which decreases the expected prize. This fact is no surprise just after watching contestants behavior in different decision situations. Usually contestants who eliminated all valuable briefcases are less risk averse because of playing for low prizes, so their attitude is completely different by having the feeling of not having anything to loose. Contestants in my sample acknowledge this result. This result seems to fit the study by Thaler and Johnson, (1990) which is based on the prospect theory by Kahneman and Tversky, (1979). They discuss the fact, that the contestants are more risk seeking after experiencing failure, because they do not adapt to their situation yet. They change their attitude after few rounds though, when they start to adopt and their attitude is changing back to being risk averse and choose the „Deal“. On the other hand, it happens in some cases, that after being risk seeking after the previous loss they open the briefcases with highest prizes, they do not adopt to the loss and take the risk till the end.

On the other hand prior_gains as all the other variables do not have important interpretational role for the model. Increasing the age by one year would decrease RRA by 0,000559. If the contestant is a woman, RRA is lower by 0,17. In my sample, there are more men than women. It is probably influenced by the size of the sample (having just 28 games out of more than 90). If the contestant reached higher education (college degree), RRA is lower by 0.3. More people from my sample seem to be just high school graduates considering their work positions. Since there are no educational requirements and there is no need to have high skills to be participant in this game I do not concentrate on higher percentage of contestants with lower education.

I choose this model with the wealth level zero also because of the importance of R-squered, which obtains the highest value here. The variables I include to the model interprete 47 % of all changes in dependent variable.

From the results it is also observable, that 11 observations were dropped, which may have important influence on the results. There were five observations dropped because of missing data of age and education. The other six were dropped because of existence of contestants who have specific behavior and who continue to the last round to open the original briefcase and may misrepresent the sample. The Table IV. below shows the comparison of the contestants who went to the last round and contestants who finished the game in 8^{th} or earlier round.

Table IV.

	age	gender	education	stop round	prize won	prize in briefcase
Average all	41,333333	0,4285714	0,375	7,3214285714	254903,21429	766639,5
Average last round	28,166667	0,6666667	0,3333333333	9	898,33333333	898,3333333333
Average all except last round	45,095238	0,3636364	0,3888888889	6,8636363636	324177,27273	975478

It is observable that contestants more risk seeking who were willing to continue to open the original briefcase were younger than the rest of the sample. The reason for that may be caused by having less experience with money and they may have more positive attitude when entering the next round. They may be also more influenceable by the audience. More contestants in the last round were women. There is again the problem of small sample. On the other hand it may be caused by the position in the family, where the husband is the head of the family and wife is not the one who is supposed to make the money, so she bears less responsibility when it comes to decision-making process. The huge difference comes with the prize won. It is observable that people who got in the last round won just small amounts. Because there were no other big amounts remaining, they may have decided to continue to the last round having no aversion towards risk anymore.

Conclusions

Since the game „Deal or no deal“ seemed quite well-suited for observing the decision-making process on Dutch and Australian data in the past, I test it also on the Czech data. Because of not being necessary to have special education or computational skills, it is not a surprise that the main result is similar to the previous study.

In this paper the two-stage methodology is used. The data set containing 28 games broadcasted on Prima TV in the Czech Republic between years 2007 and 2008 is used for computing RRA, which stands for the Arrow-Pratt coefficient of relative risk aversion. I think over the contestants under myopic and hyperopic framing and the average RRA lies roughly between 0.3 and 0.7. The higher values are observable under the myopic framing and the maximum values are more than 2 (2.49), which represent the risk averse contestants, on the other hand the minimum is less then 0, which represents the risk seeking behavior. These differences in RRA acknowledge the differences in contestant's behavior generally. I used different wealth levels to observe how the behavior is influenced by this fact. The first level is considered as zero, explaining the situation when the contestant does not consider any wealth when entering the game. As the second level I choose value 8 000 CZK and the last one I use value 25 000 CZK. The contestants with higher wealth level are generally more risk averse. In the higher rounds though, after the elimination of high values briefcases it is observable that contestants with higher wealth level are more risk seeking because of not being attracted by quite low bank-offers. After decreasing the bank-offer the contestant is no longer motivated by the low offers, comparing the offer to his own wealth and decides to continue playing.

Prior losses is the most significant variable in my model, so the differences in RRA may be explained by the results in previous rounds, where contestant gets experience. Because of not adapting to losses yet, the contestant's attitude is more risk seeking after eliminating high valued briefcases. This result seems to confirm the study by Thaler and Johnson, (1990), where they came up with the idea based on the prospect theory by Kahneman and Tversky, (1979). Contestants are more risk seeking after experiencing failure, because of not adapting to the situation yet. After few rounds though, they start to adopt and to be risk averse and choose the „Deal“. On the other hand, in some cases, when they are risk seeking after the previous loss and they open the briefcases with highest prizes (as discussed above) they do not adopt to the loss and take the risk till the end.

There is much more to study on this topic. It is necessary to consider more the contestants who finish the game by opening the original briefcase. This situation may be very important for the whole model. It would be also very interesting to use the whole sample and to consider not just myopic and hyperopic framing, but also the contestants with full rationality.

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- The graphs made by http://www.wolframalpha.com

Figure 1

Figure 1

This figure shows how the screen with all the prizes looks at television and in the game. There are all 26 prizes and this look is to the screen after first round before the bank-offer is made. Dark fields represent eliminated prizes after first round. At the top there is displayes the bank-offer once it is made.

	Bank Offer	
1		10000
2		20000
5		30000
10		40000
50		50000
100		100000
200		250000
500		500000
1000		1000000
2000		1500000
5000		2500000
7500		5000000