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Deal or No Deal?
Decision-making under Risk in a Large Payoff Game Show

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Abstract

The popular television game show "Deal or No Deal" offers a unique opportunity for analyzing decision making under risk: it involves very large stakes, simple take-or-leave decisions that require minimal skill or strategy and near-certainty about the probability distribution. Based on a panel data set of the choices of contestants in all game rounds of 53 episodes from Australia and the Netherlands, we find an average Pratt-Arrow relative risk aversion (RRA) between roughly 1 and 2 for initial wealth levels between €0 and €50,000. The RRA differs substantially across the contestants and some even exhibit risk seeking behavior. The cross-sectional differences in RRA can be explained in large part by the previous outcomes experienced by the contestants during the game. Most notably, consistent with the "break-even effect", the RRA strongly decreases following earlier losses and risk seeking arises after large losses.

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Deal or No Deal?

Decision making under risk in a large-payoff game show

The popular television game show "Deal or No Deal" offers a unique opportunity for analyzing decision making under risk: it involves very large stakes, simple take-or-leave decisions that require minimal skill or strategy and near-certainty about the probability distribution. Based on a panel data set of the choices of contestants in all game rounds of 53 episodes from Australia and the Netherlands, we find an average Pratt-Arrow relative risk aversion (RRA) between roughly 1 and 2 for initial wealth levels between €0 and €50,000. The RRA differs substantially across the contestants and some even exhibit risk seeking behavior. The cross-sectional differences in RRA can be explained in large part by the previous outcomes experienced by the contestants during the game. Most notably, consistent with the "break-even effect", the RRA strongly decreases following earlier losses and risk seeking arises after large losses.

I Introduction

THE AMOUNTS AT STAKE are relevant for the validity of various theories of risky choice. For example, there exist good reasons to question the expected utility theory for small stakes. As Rabin and Thaler (2001) note, the theory says that risk attitudes derive from changes in marginal utility associated with fluctuations in lifetime wealth and hence people will not be averse to outcomes that do not significantly influence lifetime wealth. Furthermore, Rabin (2000) shows theoretically that inferring the risk aversion for small stakes leads to unreasonably high risk aversion for large stakes and reasonable values for large stakes are obtained only when we assume near risk neutrality for small stakes.

The stakes are also relevant for empirical research on risky choice. A large part of the empirical research relies on laboratory experiments or classroom experiments. The key advantage of such experiments relative to real-life data is the possibility to control the probability distribution of the choice alternatives and to ensure that the distribution is known to the decision maker. Nevertheless, experiments generally use hypothetical or small real stakes that may not be large enough to induce subjects to act optimally and reveal their true preferences and beliefs. For example, Holt and Laury (2002) show that the use of large real stakes leads to substantially more risk averse behavior than the use of hypothetical or small real stakes does.

Some empirical studies try to deal with the stakes problem by using small nominal amounts in relatively poor countries, so that the amounts are relatively large in real terms for the subjects; for example, Binswager (1980, 1981), Quizon *et al*. (1984) and Kachelmeier and Shehata (1992). Still, the stakes in these experiments typically are not larger than a monthly income, and we may ask if the results are representative for larger amounts. Unfortunately, it seems impossible, financially speaking, to use larger amounts in experiments.

Another approach is to use field study data from television game shows. Notwithstanding some limitations of game show data, the key advantage is that large, real money amounts are at stake. Examples include the shows "Card Sharks" (Gertner, 1993), "Jeopardy!" (Metrick, 1995), "Illinois Instant Riches" (Hersch and McDougall, 1997), "Lingo" (Beetsma and Schotman, 2001), "Hoosier Millionaire" (Fullenkamp *et al*., 2003) and "Who Wants to be a Millionaire?" (Hartley *et al*., 2005).[1]

Unfortunately, analyzing game show data is no panacea. In most game shows, the stakes are still modest. One noteworthy exception is “Hoosier Millionaire”, where contestants can win $1,000,000. However, in this show, the stakes exhibit little variation across the different game rounds and most contestants stop after the first game round, which makes it difficult to estimate the risk attitudes of the contestants for a wide range of outcomes. Besides this, the prizes are long-term annuities, introducing the possible behavioral biases of time discounting (see for example Thaler, 1981). Furthermore, many game shows involve skill (for example, the ability to guess words in “Lingo”, to answer quiz questions in “Who Wants to be a Millionaire?”, or to correctly assess complicated or unknown probabilities in “Card Sharks” and “Jeopardy!”) or strategy (for example, to beat opponents in “Jeopardy!”). This makes it difficult for contestants to assess the appropriate probability distribution and introduces a layer of uncertainty in addition to the risk of the game. The same is true for game option elements such as the “lifelines” in “Who Wants to be a Millionaire?”, which generally are difficult to value.

In this study, we will analyze the decisions made in the main game of the blockbuster television game show “Deal or No Deal”. This show was developed by the Dutch production company Endemol and first aired (in its current format) in the Netherlands in December 2002. The game show soon became very popular and was exported to many other countries around the world. For analyzing risky choice, “Deal or No Deal” has a number of favorable design features. The stakes are very high: with a maximum prize of €5,000,000 and an average prize of roughly €400,000 (in the Netherlands), the game show can send contestants home multimillionaires—or empty-handed. Furthermore, unlike other game shows, “Deal or No Deal” involves only simple take-or-leave decisions that require minimal skill or strategy. Also, the probability distribution is simple and known with near-certainty. Because of these features, “Deal or No Deal” seems well-suited for analyzing real-life decisions involving real and large risky stakes.

Using 53 shows aired in Australia and the Netherlands in 2002-2005, we estimate the Pratt-Arrow relative risk aversion (RRA) and examine how it varies across contestants, using a constant relative risk aversion (CRRA) expected utility model. The game involves multiple game rounds with decisions to “Deal” or “No Deal”, leading to a panel data set with a time-series dimension (the game rounds) and a cross-section dimension (the contestants). From the time-series, we infer a RRA estimate for every individual contestant. Furthermore, we try to explain the cross-sectional differences in the RRA estimates with characteristics of the contestants and the state-of-the-game they faced.

Since it involves multiple game rounds, “Deal or No Deal” seems particularly well-suited for analyzing the role of earlier losses and gains experienced by the contestant during the previous game rounds. Thaler and Johnson (1990) conclude that risky choice is affected by prior outcomes in addition to incremental outcomes due to decision-makers incompletely adapting to recent losses and gains or “stickiness” of the reference point that separates gains from losses. The game show seems less suitable for analyzing the influence of the shape of the distribution of incremental outcomes. All contestants generally face a similarly shaped distribution in a given game round, apart from the mean outcome. This complicates the cross-sectional testing of the effect of loss aversion and subjective probability distortion, phenomena documented in, for instance, Kahneman and Tversky (1979) and Tversky and Kahneman (1991).

The remainder of this study is structured as follows. Section II describes the game show in greater detail. Section III discusses our data material. Section IV explains our two-stage research methodology. Section V discusses our empirical results. Finally, Section VI presents concluding remarks and suggestions for future research.

II Description of the game show

The television game show "Dea l or No Deal" is developed by the Dutch production company Endemol and was first aired in the Netherlands in its current format in December 2002. The show soon became very popular and was exported to many other countries, including Australia.[2] The format of the program is similar for all editions around the world.

Each episode consists of two parts: an elimination game based on quiz questions in order to select one finalist from the audience and a main game in which "Deal or No Deal" is played by the finalist. Only the main game is subject to our research. Except for determining the identity of the finalist, the elimination game does not influence the course of the main game.[3]

The main game starts with 26 numbered briefcases that contain hidden money amounts that are randomly drawn from a known, fixed set of prizes ranging from very small to very large. In the Dutch edition for example, the prizes range from €0.01 to €5,000,000.[4] One of the briefcases is selected by the contestant and this briefcase is not to be opened until the end of the game.

The game is played over a maximum of nine rounds and each round a "bank" tries to buy the briefcase from the contestant by making him or her an offer. Prior to each bank offer, the finalist obtains information about the unknown prize in his or her briefcase by choosing one or more of the other 25 briefcases to be opened. As more and more briefcases are opened and the prizes inside are revealed, the uncertainty regarding the prize in the contestant's own briefcase gradually disappears as the game progresses.

In the first round, the finalist selects six briefcases to be opened and subsequently a first bank offer is made based on the remaining 20 prizes. If the contestant accepts the offer ("Deal"), he or she walks away with this sure amount and the game ends; if the contestant refuses the offer ("No Deal"), play continues and he or she enters the second round.

In this second round, the finalist has to open five more briefcases, followed by a new bank offer. Once again, he or she has to decide to "Deal" or "No Deal". The numbers of briefcases to be opened in the nine rounds are respectively 6, 5, 4, 3, 2, 1, 1, 1, and 1, and hence the set of remaining prizes decreases from 26 to 20, 15, 11, 8, 6, 5, 4, 3 and 2. The remaining amounts and the current bank offer are displayed on a scoreboard and need not be memorized by the player. If the contestant rejects all offers, he or she receives the prize in his or her own briefcase. Figure 1 illustrates the basic structure of the main game.

[INSERT FIGURE 1 ABOUT HERE]

To provide further intuition for the game, Figure 2 shows a typical example of how the main game is displayed on the television screen. A close-up of the contestant is shown in the centre and the prizes in the 26 briefcases are listed to the left and right of the contestant. Eliminated prizes are shown in a dark color and remaining prizes are in a bright color. The bank offer is displayed at the top of the screen.

[INSERT FIGURE 2 ABOUT HERE]

During the course of the game, as additional briefcases are opened, more and more information about the prize in the contestant's briefcase becomes available, changing the shape of the statistical distribution of the prize that will be taken home. Apart from the amounts in the unopened briefcases, also the *number* of unopened briefcases has an important effect on the statistical distribution. Table I shows how the shape of the distribution changes on average as the game evolves through the nine rounds. The shown numbers are averages across all possible scenarios; in a specific episode, the distribution typically differs from what is reported here, depending on the specific set of remaining prizes. The average expected value does not depend on the game round number. By contrast, the standard deviation, skewness and kurtosis fall significantly as more briefcases are opened. Thus, during the course of the game, the contestants generally are confronted with a decreasingly dispersed, decreasingly skewed and decreasingly fat-tailed prize distribution. In fact, in the ninth round, the distribution is perfectly symmetric, because the contestant then faces a 50/50 gamble involving only two remaining briefcases. This effect of the number of briefcases on the shape of the prize distribution is important when we try to explain the differences in risk attitude between the contestants; see Section IV.

[INSERT TABLE I ABOUT HERE]

Not surprisingly, bank offers generally are related to the mean of the prizes in the unopened briefcases. However, the bank becomes more generous as the game progresses, making offers that are high relative to the mean. This strategy obviously serves to encourage contestants to continue playing the game and to gradually increase excitement. Usually, the bank is also more generous to unfortunate players who opened the more valuable briefcases and saw their expected winnings tumble. Although the contestants do not know the exact bank offers in advance, the bank behaves consistently according to a clear pattern. We will discuss this pattern later. It should also be pointed out that the decisions to "Deal" or "No Deal" are generally based on the expectations regarding subsequent bank offers, rather than the expected prize in the contestant's briefcase, witness a large majority making a "Deal" at some point instead of playing the game until the end.

Although the above description applies to the episodes of "Deal or No Deal" in our sample, the formats of other editions around the world are very similar. Differences, if any, mainly concern the set-up of the elimination round, the number of briefcases, the prizes in the briefcases and the presence or absence of special options in the main game.

III Data

In this study, we focus on 53 episodes of "Deal or No Deal" that were broadcast in the Netherlands (33) and in Australia (20) in the years 2002-2005. The Dutch edition of "Deal or No Deal" is named "*Miljoenenjacht*". A key advantage of the Dutch shows is the relatively high amounts at stake: the contestants may go home with as much as €5,000,000. The first Dutch episode of "Deal or No Deal" was aired on December 22, 2002.[5] Up to and including June 2005, the show was aired 33 times, divided over five series of weekly episodes and one individual episode. The format of the main game was not changed during the sample period. Part of the 33 shows are recorded on videotape by the authors and tapes of the remaining shows are obtained from the Dutch broadcasting company TROS.

In Australia, the debut of "Deal or No Deal" was on July 13, 2003, and the first season lasted for 16 weekly episodes.[6] The show returned on television in February 2004, but as a shorter, daily edition with decimated prizes. Not much later, randomly offered game options, known as "Chance" and "Supercase", were added. These option elements complicate the analysis by introducing a layer uncertainty in addition to the relatively simple risk structure of the original game.[7] Our focus is therefore on the earlier episodes with large prizes and no special options. Four more shows with large prizes were aired on an incidental basis in August and September 2004 and we included those four shows as well. Copies of all 20 episodes are obtained from a private collection of game show recordings.[8]

For every contestant, we collect data on the eliminated and remaining briefcases, bank offers and "Deal"/"No Deal" decisions in every game round, leading to a panel data set with a time-series dimension (the game rounds) and a cross-section dimension (the contestants). Furthermore, at the beginning of "Deal or No Deal", the game show host asks the contestant to introduce himself or herself to the public. Based on this introduction talk and other conversations with the host during the course of the game, we collect data on contestant characteristics such as age and education.

Table II shows summary statistics for our sample.

[INSERT TABLE II ABOUT HERE]

IV Methodology

We use a two-stage methodology. The first stage uses a backward induction method to estimate the Pratt-Arrow relative risk aversion (RRA) for every individual contestant based on the time-series of game rounds. In the second stage, we use multivariate regression analysis to explain the cross-sectional variation in the RRA estimates with the characteristics of the contestants and the state-of-the-game they faced.

Stage 1: Estimate RRA for each individual contestant

We index contestants by $i = 1, \cdots, N$ and game rounds by $r = 1, \cdots, 10$. Furthermore, we use R for the round in which the game is stopped (i.e., the contestant accepts the bank offer or, for R=10, the game is played to the end) and W for contestants' initial wealth. In a given round r, the set of remaining prizes is denoted by x_r and the associating number of remaining briefcases by $n(x_r)$. For a given r, x_{r+1} is a subset of the $n(x_{r+1})$ elements from x_r. The collection of all such subsets is denoted by $X(x_r)$. Preferences are modeled using the CRRA utility function

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

with γ for the RRA coefficient. We use $b(x_r)$ for the bank offer as a function of the set of remaining prizes x_r. Since the bank offers are highly predictable, this function is treated as deterministic and known to the contestants.

We now turn to analyzing the expected utility of deciding "No Deal" given the set of remaining prizes x_r. The analysis is complicated by the contestant's option to accept a bank offer in a later round, similar to the "early-exercise option" of American-style stock options and real options in investment projects. Therefore, the expected utility of a "No Deal", or playing another round, exceeds that of playing the game to the end. In the spirit of the decision-tree approach to valuing American-style options and investment projects, we can determine the expected utility by means of backward induction. Starting with the penultimate round $(r = 9)$, we can determine the optimal take-or-leave decision in every round, accounting for the possible scenarios and the optimal decisions in subsequent rounds. Given x_r, the statistical distribution of x_{r+1} is known:

$$\Pr[x_{r+1} = y | x_r] = \begin{pmatrix} n(x_r) \\ n(x_{r+1}) \end{pmatrix}^{-1} \tag{2}$$

for any given $y \in X(x_r)$, i.e., the probability is simply one divided by the number of possible combinations of $n(x_{r+1})$ out of $n(x_r)$. Thus, the expected utility of a "No Deal" is given by:

$$\underbrace{g(y,\gamma,W,b)}_{\substack{\text{expected utility of}\\ \text{continuing given the}\\ \text{prizes } y}} \equiv \sum_{z \in X(y)} \max\{\underbrace{u(b(z)|\gamma,W)}_{\substack{\text{utlity of accepting}\\ \text{the offer given the}\\ \text{prizes } z}}, \underbrace{g(z,\gamma,W,b)}_{\substack{\text{expected utility}\\ \text{of continuing given}\\ \text{the prizes } z}}\} \times \underbrace{\begin{pmatrix} n(y) \\ n(z) \end{pmatrix}^{-1}}_{\substack{\text{probability of}\\ \text{prizes } z \text{ given}\\ \text{prices } y}} \tag{3}$$

for *r*=1,…,9. When *r*=10, only the contestant's own briefcase remains, so the "bank offer" equals the prize in this last briefcase, i.e., $b(x_{10}) = x_{10}$, and the contestant need not make any further decisions. Thus,

$$g(x_{10},\gamma,W,b) = u(x_{10}|\gamma,W) \tag{4}$$

In this study, we will derive RRA estimates for the individual contestants. The estimates are inferred from the contestant's decisions to "Deal" or "No Deal" in different game rounds. Specifically, the RRA is estimated such that the expected utility of continuing exceeds that of stopping in the game rounds where the contestant chooses "No Deal" and the reverse for a "Deal". For a given contestant *i* and a given round *r*, we may compute the "switching value" or critical RRA value at which a contestant would be indifferent between stopping ("Deal") and continuing ("No Deal") in the following manner:

$$\hat{\gamma}_{i,r}(W,b) \equiv \{\gamma : g(x_{i,r},\gamma,W,b) = u(b(x_{i,r})|\gamma,W)\} \tag{5}$$

If a contestant accepts a bank offer, then his or her certainty equivalent must be lower than the offer. In other words, his or her RRA will be higher than the switching value. Therefore, the switching value from the last round (*R*) provides a lower bound, $\hat{\gamma}_i^{\mathrm{L}}(W,b) \equiv \hat{\gamma}_{i,R}(W,b)$ to the contestant's RRA. Similarly, RRA will be lower than the switching value $\hat{\gamma}_{i,r}(W,b)$ from every earlier round ($r \leq R-1$). Since the bank offer as a percentage of the expected prize typically increases, the penultimate round (R-1) generally yields the lowest upper bound. More generally, we use $\hat{\gamma}_i^{\mathrm{U}}(W,b) \equiv \min_{r=1,\ldots R-1}(\hat{\gamma}_{i,r}(W,b))$ as the upper bound to the contestant's RRA. In this study, we will report both the upper bound and the lower bound.[9,10] Furthermore, to estimate the RRA, we use the average of the two bounds:

$$\bar{\hat{\gamma}}_i(W,b) \equiv \tfrac{1}{2}(\hat{\gamma}_i^{\mathrm{L}}(W,b) + \hat{\gamma}_i^{\mathrm{U}}(W,b)) \tag{6}$$

The upper and lower bounds by construction are biased estimates, and by averaging, the positive and negative errors can be expected to cancel out on average, leading to a better estimate for the true RRA. The upper and lower bound generally show the same pattern, as we will show in Section V. Thus, while the averaging is important for estimating the level of RRA, it does not materially affect our analysis of the relative differences in risk attitude between contestants.

When using the RRA estimator $\bar{\hat{\gamma}}_i(W,b)$, we have to specify the appropriate wealth level (W) and bank function (b).

Risk aversion estimates generally rely critically on the initial wealth of the individuals. The higher the initial wealth level, the higher will be the RRA needed to explain a "Deal". Unfortunately, the initial wealth of the contestants is not known, due to, e.g., intangible components such as human capital. Fortunately, the stakes in "Deal or No Deal" are relatively high compared with any reasonable a priori estimate for initial wealth and hence we may expect our conclusions to be relatively robust with respect to the assumed wealth level. In this study, the wealth levels are linked to the median household income in the Netherlands and Australia, roughly €25,000 during the sample period. Specifically, we consider wealth levels of €0, €25,000 and €50,000. Monetary values from the Australian episodes are translated into Euros by using a rate of €0.60 per AU$, roughly corresponding with the average exchange rate during our sample period.[11]

The results will also depend strongly on the assumed expectations regarding the bank offers. The higher the expected offers, the more valuable the contestant's "early exercise option" and the higher the RRA needed to explain a "Deal". Fortunately, the bank in the shows we analyzed seemed to adhere to a set of simple rules of thumb. Specifically, the offer as a percentage of the expected prize typically increases in a predictable manner from about seven percent in the first round to about hundred percent in the later rounds. Also, if a contestant opens the more valuable briefcases and the expected prize plummets, the bank typically compensates part of the loss by making a relatively generous offer, often even exceeding the expected value. Table III shows summary statistics for the bank offers in our sample. The offers clearly depend on the game round number and on $for_{i,r} = E(x_{i,10} | x_{i,r}) / E(x_{i,10})$, or the expected prize in the relevant game round as a fraction of the initial expected prize—an indicator of the fortune experienced during the game. The bank behaves in a similar way in both countries.

[INSERT TABLE III ABOUT HERE]

To further quantify the bank behavior, we use the following two-parameter model:

$$E[b(x_{i,r})] = E(x_{10}|x_{i,r})(1-\exp(\alpha_0 r^2))\exp(\alpha_1(for_{i,r}^{-1}-1)) \quad (7)$$

for $i = 1,\cdots,N$ and $r = 1,\cdots,9$. The functional form is selected such that the offers lie between zero and 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 $\alpha_1 \geq 0$.

We estimate the two unknown parameters, α_1 and α_2 , by minimizing the sum of squared errors in the full sample of bank offers for all contestants and all rounds.[12] The estimated parameter values are $\hat{\alpha}_0 = -0.050$ and $\hat{\alpha}_1 = 0.002$, and yield the pattern shown in Panel A of Figure 3. Clearly, the percentage offer increases with the round number and also it increases following large losses. Panel B shows that the model gives a remarkably good fit, with an overall R-squared of 93%.

[INSERT FIGURE 3 ABOUT HERE]

Since this simple pattern is relatively obvious after seeing a couple of shows, we assume that the contestants are aware of this pattern. We assume a deterministic bank function given by model (7) with parameters equal to our estimates $\hat{\alpha}_0 = -0.050$ and $\hat{\alpha}_1 = 0.002$. Of course, for the contestants in the first shows, when the show had not been aired before, the pattern may not have been so obvious. Also, there remains some uncertainty about the bank offer. Most notably, the bank offer to the unluckiest contestants is relatively uncertain and ranges roughly speaking between 100 and 200 percent of the expected prize. Still, the bulk of the uncertainty comes from the uncertainty regarding the contents of the briefcases, especially if large amounts are at stake, and we therefore feel confident to assume a deterministic bank function. Using a stochastic bank function would add another layer of uncertainty for the contestants and presumably would yield RRA estimates below the values reported here.

Our RRA estimates assume that the contestants are fully rational and account for all possible outcomes and decisions in all game rounds. This assumption can obviously be questioned. For example, contestants may adopt a "myopic frame" that focuses only on the distribution characteristics of the bank offer in the next game round, ignoring the option to reject the offer and continue play thereafter. Similarly, contestants with a "hyperopic frame" would focus only on the prize in the chosen briefcase that will be opened at the end of the show, ignoring the options to "Deal" in intermediate rounds. We have few prior arguments for choosing a particular frame. A simplified frame that ignores particular options would lower the value of a "No Deal" decision relative to the value of accepting the certain alternative and hence would yield RRA estimates below the values reported here. However, as will be shown later, our main finding in this study relies on risk seeking in particular circumstances and this pattern is not materially affected by myopic or hyperopic framing.

Stage 2: Attribute the differences in RRA

Having estimated the individual RRA scores $\bar{\gamma}_i(W,b)$, $i = 1,\cdots,N$, we subsequently use multivariate regression analysis to explain the cross-sectional variation in the estimates. To explain the variation in the RRA estimates, we considered various variables:

A. Contestant characteristics

At the beginning of "Deal or No Deal", the contestant is asked to introduce himself or herself to the public. Based on this introduction and other conversations with the game show host during the course of the game, we are able to determine some characteristics of the contestant. We include the following variables as regressors in our analysis:

A1. Age (years)

A2. Gender (female/male)

A3. Education (high/low)

A4. Country (Netherlands/Australia)

In some cases, the contestant's age is not explicitly stated. In these cases, we estimate the missing values based on the physical appearance of the contestant and other information revealed in the introduction talk, e.g., the age of children. Gender is obviously easy to determine, but it should be noted that usually, the contestant's spouse sits in the audience and is consulted on the decisions to "Deal" or "No Deal". Thus, decisions are often taken effectively by a male-female couple, which may obscure a possible gender effect. Although a contestant's level of education is only rarely explicitly mentioned, it is often clear from the stated profession. We assign "high" to bachelor-degree level or higher (including students) and to equivalent work experience.

B. Previous gains and losses

As discussed above, fortune experienced during the game can be measured by the ratio of current expected prize to initial expected prize. Since the RRA estimate is the average of two bounds calculated from different game rounds, we compute the average of the fortune values in the same two rounds; the resulting variable is denoted by for_i.[13] To distinguish between reactions to gains and losses, we introduce the dummy variable $loss_i = 1_{for_i \leq 1}$ that takes the value one for losses and zero for gains, and its complement $gain_{i,r} = 1_{for_i > 1} = 1 - loss_i$. The following two regressors are included:

B1. Prior losses: $(for_i - 1) \times loss_i$

B2. Prior gains: $(for_i - 1) \times gain_i$

Statistically speaking, these regressors are exogenous, which simplifies the analysis of the causal link between them and the dependent variable (RRA); risk aversion cannot affect the prior outcomes, but prior outcomes may affect risk aversion. Furthermore, prior outcomes are random and hence they are uncorrelated with the other regressors in the model, which simplifies the disentangling of the various drivers of RRA.

C. Shape of the distribution

To examine the role of the shape of the distribution of incremental outcomes, we include the following two shape parameters:

C1. Standard deviation of the remaining prizes, scaled by the expected prize

C2. Skewness of the remaining prizes

The expected prize is already included in the fortune measure. Higher-order statistics are not included, because mean, standard deviation and skewness almost completely describe the distribution. For example, skewness and kurtosis have an almost perfect correlation of 95 percent in this game.

Due to the structure of the game, the effect the shape parameters may be affected by endogeneity bias. Specifically, the RRA estimates generally are obtained from the penultimate and ultimate game rounds. Due to the increasing trend for the percentage bank offer, the relevant round numbers will be negatively correlated with the RRA estimates. Unfortunately, the shape of the distribution is also determined in part by the round number (and hence by the RRA), which may obscure the causal links between the variables. For example, a low skewness is likely to occur in the later stages of the game, when many briefcases have been opened. Risk-averse contestants (high RRA), who stop early in the game always face highly skewed gambles, while the more adventurous contestants (low RRA) choose to play the game until the later stages, when the skewness is low. Thus, we may find a correlation between RRA and skewness even if there is no causal relationship between the two. To avoid such spurious correlation, we use the shape parameters in deviation from the expected values for these parameters in the relevant game round; see Table I. Again, as for the fortune variable, we use the average of the values for the two rounds used to estimate the RRA.[14]

We will use the following linear regression model:

$$E[\bar{\gamma}_i(W,b)] = \beta_0 + \sum_{j=1}^{K} \beta_j z_{i,j} \quad i = 1,\cdots,N \tag{8}$$

where $z_{i,j}$ is the value of the jth regressor, $j = 1,\cdots,K$, for the ith contestant, $i = 1,\cdots,N$. The unknown parameters are estimated by means of ordinary least squares (OLS) regression analysis.

V Results

A. Individual RRA scores

Table IV summarizes our RRA estimates. For a wealth level of €25,000, we find an average RRA of 1.61. Furthermore, the degree of risk aversion differs strongly across the contestants, some exhibiting strong risk aversion (RRA>5) and others risk seeking (RRA<0). As expected, the estimates decrease if we lower the initial wealth level and increase if we raise the wealth level. However, due to the large amounts at stake, the changes are relatively modest. For example, lowering the wealth level from €25,000 to €0 yields an average RRA of 1.01 and raising the wealth level to €50,000 yields an average RRA of 2.15. Furthermore, the relative differences in RRA across individuals are not materially affected by the wealth level. For this reason, we will mainly focus on the results for *W*=€25,000 in the remainder of this study.

Other game show studies found RRA estimates ranging from 0.64 (Fullenkamp *et al*., 2003) to 6.99 (Beetsma and Schotman, 2001).[15] Interestingly, our estimates are very similar to those in the Hartley *et al.* (2005) study of "Who Wants to be a Millionaire?", another large-stakes game show. They estimate the initial wealth level at *W*=£410 (roughly €600) and the RRA at 1.02, almost identical to our RRA=1.01 for *W*=0. Furthermore, in our study, for *W*=0, the dispersion of the RRA estimates is smallest and the explanatory power of the regression model is highest, supporting a choice of a low wealth level.[16] Nevertheless, as we will see below, our conclusions about the drivers of RRA are robust with respect to the wealth level.

The finding that the average RRA lies between roughly 1 and 2 for wealth levels between €0 and €50,000 is important because it shows that the expected utility framework is consistent with observed choice behavior for a "reasonable" or "moderate" degree of risk aversion when large, real money amounts are at stake, even for relatively high wealth levels.

[INSERT TABLE IV ABOUT HERE]

B. Regression analysis

We now turn to explaining the cross-sectional differences in RRA. Panel A of Table V shows the OLS regression output for the full model with all regressors. Overall, roughly half of the variation in the RRA estimates can be explained by the model. The most important explanatory variable is the prior loss variable. The positive sign suggests that the RRA decreases following losses. In fact, contestants facing a large reduction in the expected prize during the game generally become risk seeking; they continue to play even if the bank offers more than the expected prize.

By contrast, the prior gain variable has no explanatory power. The other variables also have no significant explanatory power. For the contestant characteristics, this may be explained in part or in whole by the lack of sample variation. Unlike a laboratory experiment, we cannot control these characteristics in game shows. A substantial part of the contestants in our sample are white, middle-aged males and all live in wealthy, developed countries. The shape of the prize distribution also has no important role in explaining RRA. This finding may simply reflect that there is hardly any variation in the shape parameters after correcting for the effect of the game round number; as discussed in Section II, all contestants generally face a similarly shaped distribution in a given game round, apart from the mean prize. Panel B shows the results for a reduced version of the regression model that includes only the prior loss variable. Clearly, hardly anything is lost by excluding the other regressors and prior losses seem the main factor driving RRA in our sample.

[INSERT TABLE V ABOUT HERE]

We interpret the lower RRA following losses as evidence for a "break-even effect" (Thaler and Johnson, 1990): decision-makers become more willing to take risk after previous losses due to incomplete adaption to losses, or a "sticky" reference level that separates gains from losses.[17] The interpretation as a "break-even effect" obviously is not consistent with the expected utility theory and suggests that phenomena such as the framing in terms of loss and gains and the slow updating of the reference level are relevant also when large, real money amounts are at stake.

An alternative interpretation is a wealth effect: RRA may be an increasing function of wealth (IRRA), irrespective of gains and losses relative to a reference wealth level. We reject this alternative interpretation for several reasons. First, IRRA does not explain why the RRA becomes negative. In the worst case, the contestant goes home empty-handed and returns to his or her initial wealth level. Thus, to assume that a negative RRA after large losses reflects IRRA is to assume that contestants were risk seekers before they entered the game show—an implausible assumption. Related to this, the RRA increases so fast that the Pratt-Arrow absolute risk aversion also increases in the domain of large losses (IARA). However, economic theory typically assumes decreasing ARA (DARA).[18]

Furthermore, there is substantial variation in the prize money between the two countries in our sample: the Australian show involves a maximum prize of AU$2,000,000, or roughly €1,200,000, while the Dutch show has a maximum of €5,000,000—more than four times higher. If the RRA would be affected significantly by the wealth level per se, then we would expect different patters for the two countries. However, the same patterns arises in every country, witness for example the insignificant value for the regression coefficient for the country dummy variable—IRRA would predict a significantly higher RRA in the Netherlands due to the higher stakes.

The different stakes in the two countries also suggests another way to disentangle the effects of fortune and wealth. Specifically, the 23 Dutch "losers" (fortune<1.13) have an average fortune of 0.63, an average expected prize of roughly €189,000 and an average RRA of 1.32. We may disentangle the two explanations by considering two subsets of Australian contestants: (i) the largest subset with average stake of roughly €189,000 and (ii) the largest subset with average fortune of roughly 0.63. The first subset consist of 12 Australian "winners" (fortune>0.87) and has an average fortune of 1.24, an average expected prize of roughly €189,000 and an average RRA of 2.79, significantly higher than the value of 1.32 (p-value=0.00). Since we control for expected prize, the higher RRA confirms the "break-even effect"; the Dutch "losers" have a lower risk aversion because they experienced prior losses. The second subset involves 11 Australian "losers" (fortune<1.00) with an average fortune of 0.62, an average expected prize of roughly €57,000 and an average RRA of 1.16, not significantly different from the value for the Dutch "losers" (p-value=0.62). In brief, controlling for fortune or stakes, the results support the "break-even effect" instead of the "wealth effect".

C. Robustness analysis

Our conclusions regarding the *level* of RRA depend on the assumptions about the preferences, the initial wealth level and the bank behavior. However, the conclusions regarding the *differences* in RRA and the *drivers* of these differences are more robust. For example, Table VI shows the effect of changing the initial wealth level to *W*=€0 (Panel A) or to *W*=€50,000 (Panel B). The general pattern is the same: a large part of the differences in RRA can be explained by prior losses. However, for low initial wealth levels, the differences in RRA are smaller and a smaller value of the regression coefficient for prior losses is needed to explain the differences, while the reverse is true for high initial wealth levels. The wealth level also affects the effect of prior gains. Specifically, the RRA of high-fortune contestants is less sensitive to the initial wealth level than the RRA for medium-fortune contestants. Thus, decreasing (increasing) the initial wealth leads to a positive (negative) relationship between RRA and prior gains. Nevertheless, the relationship for gains always remains much weaker than for losses, both in terms of economic significance and statistical significance.

[INSERT TABLE VI ABOUT HERE]

Recall that our RRA estimator $\bar{\hat{\gamma}}_i(W,b)$ is a simple average of the upper RRA bound $\hat{\gamma}_i^H(W,b)$ and the lower RRA bound $\hat{\gamma}_i^L(W,b)$. As shown in Table VII, apart from the level of the RRA estimates, the pattern for the lower bound and the upper bound is comparable with that for the estimator $\bar{\hat{\gamma}}_i(W,b)$.

[INSERT TABLE VII ABOUT HERE]

As discussed in section IV, our RRA estimates assume that the contestants are fully rational and account for all possible outcomes and decisions in all game rounds. We may ask if the contestants do not adopt a "myopic frame" that focuses only on the bank offer in the next game round or a "hyperopic frame" that focuses only on the prize in the contestant's briefcase. Table VIII shows that the "break-even effect" also arises when using RRA estimates derived from the "myopic distribution" and the "hyperopic distribution".

[INSERT TABLE VIII ABOUT HERE]

The most striking finding in this study—risk seeking following large initial losses—seems robust for the choice of utility function, initial wealth and bank behavior. This follows from the fact that "losers" generally reject a certain bank offer that exceeds the expected prize and thus enter an "unfair gamble". Some contestants even do so in round 9, when no further bank offers follow, and only a single, simple decision remains about a simple, symmetric gamble. These contestants will be classified as risk seekers, irrespective of the precise shape of their preferences, their initial wealth level or their expectation regarding the bank's behavior. For these contestants, the only reasonable explanation that remains is that risk seeking is a reaction to their prior losses.

Witness Frank, the 36-year old male finalist in the game aired on January 1, 2005; see Table IX. In the seventh round, he opens the briefcase with the last remaining large prize (€500,000) and sees the expected prize drop from €102,006 to €2,508. The bank then offers a certain amount of €2,400, or 96 percent of the expected value. Frank rejects this offer and play continues. He also rejects subsequent offers of 105 percent and even 120 percent of the expected value and thus deliberately chooses to enter unfair gambles, to finally end up with a briefcase worth €10. In the ninth round, Frank rejects a certain €6,000 offer in favor of a 50/50 gamble of €10 and €10,000. We feel confident to classify such cases as risk seeking, because they involve a single, simple, symmetric gamble with relatively large amounts at stake. Also, unless we are willing to assume that Frank would always accept unfair gambles of this magnitude, the only reasonable explanation for his choice behavior seems a reaction to his misfortune experienced during the game.

[INSERT TABLE IX ABOUT HERE]

VI Conclusions

The popular television game show "Deal or No Deal" seems particularly well-suited for analyzing decision making under risk: it involves very large stakes, simple take-or-leave decisions that require minimal skill or strategy, and near-certainty about the probability distribution.

Based on the observed choices of contestants in the various game rounds of 53 episodes broadcasted in Australia and the Netherlands, we find an average Pratt-Arrow relative risk aversion (RRA) between roughly 1 and 2 for initial wealth levels between €0 and €50,000. These findings show that the expected utility framework is consistent with observed choice behavior for a "reasonable" or "moderate" degree of risk aversion when large real money amounts are at stake, even for relatively high wealth levels. Furthermore, the degree of risk aversion differs strongly across the contestants, some exhibiting strong risk aversion (RRA>5) and others risk seeking (RRA<0).

The differences can be explained in large part by the earlier outcomes experienced by the contestants in the previous rounds of the game. Most notably, we observe a decrease of the RRA following earlier losses. In fact, contestants facing a large reduction in the expected prize during the game generally become risk seeking. Some continue to play even if the bank offers 150 percent or more of the expected prize. It seems difficult to explain this pattern with RRA being an increasing function of wealth (IRRA). This explanation requires that the contestants were risk seekers before they entered the game show, because their wealth level at that time was the same as when they go home empty-handed. Furthermore, the same pattern emerges in both countries, despite substantial country differences in the level of prize money; the prizes in the Netherlands are more than four time higher than in Australia. This suggests that the pattern reflects prior losses and gains rather than a wealth effect per se.

Our findings are consistent with the "break-even effect" of Thaler and Johnson (1990). This interpretation obviously is not consistent with the expected utility theory and suggests that phenomena such as framing in terms of loss and gains and the slow updating of the reference level are relevant also when large, real money amounts are at stake.

We are currently expanding our data set to include episodes from Belgium and Germany, which seem directly comparable to the Dutch and Australian episodes analyzed in this study, both in terms of the prize money at stake and the contestants' wealth level. For further research it would be interesting to include also the results of shows that involve less prize money (e.g., the daily shows in Australia and the UK) and shows that are broadcasted in less wealthy countries (e.g., the shows in Mexico and Thailand), so as to further disentangle the effect of the wealth level and the effect of prior gains and losses during the game.

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Table I

Shape of the prize distribution

The table shows average shape parameters for the statistical distribution of the prizes that remain in a given game round. For every game round number, we draw 1,000,000 random samples with a sample size equal to the number of remaining briefcases in that round. Every prize in the individual samples is drawn without replacement and with an equal probability for every prize. Shown are the average values across all 1,000,000 samples of the expected value (EV) as a fraction of the initial expected value (EV_0), the standard deviation (as a fraction of the expected value), the skewness and the kurtosis. These numbers are based on the prizes in the Dutch shows; very similar results are obtained for Australia.

Game round	Remaining briefcases	EV/EV_0	Stdev/EV	Skewness	Kurtosis
Initial (0)	26	1.000	2.666	3.267	13.394
1	20	1.000	2.551	2.944	11.083
2	15	1.002	2.367	2.513	8.389
3	11	0.998	2.129	2.029	5.860
4	8	0.999	1.864	1.554	3.851
5	6	1.000	1.616	1.151	2.500
6	5	0.999	1.457	0.911	1.842
7	4	1.001	1.258	0.634	1.216
8	3	1.000	0.997	0.314	0.667
9	2	1.001	0.623	0.000	0.250

Table II

Summary statistics

The table shows descriptive statistics for our sample of 53 "Deal or No deal" episodes aired in Australia and the Netherlands in the years 2002 to 2005. The Dutch shows are videotaped by the authors or tapes are obtained from the Dutch broadcasting company TROS. Copies of the Australian shows are obtained from a private collection of game show recordings. The contestants' characteristics age and education are revealed in an introduction talk or other conversations between the host and the contestant. Age is measured in years. Gender and education are defined as dummy variables, with values of 1 assigned to respectively females and contestants with a high level of education (bachelor degree-level or higher). The stop round is the round in which the bank offer is accepted; for contestants that played the game to the end, the stop round is set equal to 10. Panel A shows summary statistics for our full sample. Statistics for the Netherlands and for Australia are shown in Panel B and C, respectively. Monetary amounts are reported in Euros; Australian Dollars are converted into Euros using an exchange rate of €0.60 for AU$1.

A. Full Sample ($N = 53$)

	Mean	Stdev	Min	Median	Max
Age (years)	42.11	11.81	20.00	40.00	70.00
Gender (female=1)	0.23	0.43	0.00	0.00	1.00
Education (high=1)	0.62	0.49	0.00	1.00	1.00
Stop round	5.25	1.96	2.00	5.00	10.00
Prize won (€)	150,469.74	187,911.65	3.00	80,000.00	816,000.00
Prize in briefcase (€)	118,755.19	373,804.72	0.01	2,500.00	2,500,000.00

B. The Netherlands ($N = 33$)

	Mean	Stdev	Min	Median	Max
Age (years)	47.55	10.99	30.00	45.00	70.00
Gender (female=1)	0.21	0.42	0.00	0.00	1.00
Education (high=1)	0.58	0.50	0.00	1.00	1.00
Stop round	4.97	1.70	3.00	5.00	10.00
Prize won (€)	207,712.42	211,249.47	10.00	151,000.00	816,000.00
Prize in briefcase (€)	136,163.70	448,236.76	0.01	2,500.00	2.500,000.00

C. Australia ($N = 20$)

	Mean	Stdev	Min	Median	Max
Age (years)	33.15	6.49	20.00	34.50	43.00
Gender (female=1)	0.26	0.45	0.00	0.00	1.00
Education (high=1)	0.70	0.47	0.00	1.00	1.00
Stop round	5.70	2.30	2.00	5.00	10.00
Prize won (€)	56,019.30	79,989.66	3.00	27,075.00	309,000.00
Prize in briefcase (€)	88,519.34	192,864.31	0.30	4,500.00	600,000.00

Table III

Bank offers

The table shows summary statistics for the bank offers in our sample of 53 "Deal or No Deal" episodes aired in Australia and the Netherlands in the years 2002 to 2005. The mean bank offer as a fraction of the expected prize is reported for each game round. The variable $for_{i,r}$ measures the fortune experienced in the previous game rounds by contestant i, and is defined as the expected prize in the relevant round (r) as a fraction of the initial expected prize. The numbers of observations are shown between parentheses. Bank offers from rounds with an expected prize less than €1000 are not considered.

Round	Total sample	The Netherlands	Australia	$for_{i,r} < 0.50$	$for_{i,r} \geq 0.50$
1	0.072 (53)	0.060 (33)	0.093 (20)	0.141 (4)	0.067 (49)
2	0.155 (53)	0.150 (33)	0.162 (20)	0.207 (7)	0.147 (46)
3	0.321 (52)	0.351 (33)	0.269 (19)	0.406 (11)	0.298 (41)
4	0.635 (43)	0.643 (26)	0.624 (17)	0.815 (20)	0.479 (23)
5	0.777 (29)	0.815 (17)	0.723 (12)	0.927 (13)	0.655 (16)
6	0.881 (20)	0.927 (12)	0.811 (8)	0.968 (13)	0.719 (7)
7	0.988 (12)	1.100 (6)	0.877 (6)	1.053 (9)	0.793 (3)
8	1.129 (5)	1.023 (2)	1.199 (3)	1.129 (5)	-
9	1.016 (2)	1.199 (1)	0.833 (1)	1.016 (2)	-

Table IV

RRA Estimates

The table summarizes our estimates for the Pratt-Arrow relative risk aversion (RRA) in our sample of 53 contestants in the game show "Deal or No Deal" in Australia and the Netherlands (2002-2005). Mean, standard deviation, minimum and maximum are shown for the upper bound $\hat{\gamma}_i^U(W,b)$, the lower bound $\hat{\gamma}_i^L(W,b)$, and the average of these two bounds $\bar{\hat{\gamma}}_i(W,b)$, and for various wealth levels (*W*=€0, *W*=€25,000 and *W*=€50,000).

		W=€0	*W*=€25,000	*W*=€50,000
Lower bound $\hat{\gamma}_i^L(W,b)$	Mean	0.560	0.805	1.003
	Stdev	0.837	1.495	2.151
	Min	-1.016	-2.530	-4.350
	Max	2.480	5.610	8.430
Average $\bar{\hat{\gamma}}_i(W,b)$	Mean	1.011	1.611	2.150
	Stdev	1.015	1.782	2.664
	Min	-0.643	-1.940	-3.365
	Max	4.170	6.320	9.745
Upper bound $\hat{\gamma}_i^U(W,b)$	Mean	1.462	2.417	3.297
	Stdev	1.379	2.427	3.713
	Min	-0.270	-1.350	-2.380
	Max	6.430	10.070	16.550

Table V

Regression results

The table shows regression results for our sample of 53 "Deal or No Deal" episodes aired in Australia and the Netherlands in the years 2002 to 2005. The dependent variable is the estimated RRA $\bar{\gamma}_i(W,b)$ at a wealth level of W=€25,000. Panel A shows the results for the full model that includes all regressors. Panel B shows the results for the reduced model that includes only prior losses as a regressor.

A. Full Model

	Coefficient	Standard error	t-statistic	p-value
Intercept	3.578	0.531	6.736	0.000
Age	0.125	0.762	0.164	0.870
Gender (f)	-0.564	0.468	-1.206	0.234
Education (h)	-0.240	0.863	-0.278	0.782
Country (NL)	-0.275	0.393	-0.701	0.487
Prior losses	6.718	1.109	6.060	0.000
Prior gains	-2.894	2.282	-1.268	0.211
Stdev/EV	-0.646	0.628	-1.029	0.309
Skewness	-0.899	0.816	-1.102	0.276
R-sq.	0.506			
Adj. R-sq.	0.442			

B. Reduced Model

	Coefficient	Standard error	t-statistic	p-value
Intercept	2.557	0.238	10.740	0.000
Age				
Gender (f)				
Education (h)				
Country (NL)				
Prior losses	6.022	0.976	6.171	0.000
Prior gains				
Stdev/EV				
Skewness				
R-sq.	0.427			
Adj. R-sq.	0.416			

Table VI

Sensitivity for wealth level

The table shows regression results for our sample of 53 "Deal or No Deal" episodes aired in Australia and the Netherlands in the years 2002 to 2005. The dependent variable is the estimated RRA $\bar{\bar{\gamma}}_i(W,b)$. Panel A shows the results for a wealth level of *W*=€0 and Panel B shows the results for *W*=€50,000.

A. *W*=€0

	Coefficient	Standard error	t-statistic	p-value
Intercept	1.297	0.291	4.455	0.000
Age	0.145	0.763	0.190	0.850
Gender (f)	-0.214	0.256	-0.833	0.409
Education (h)	-0.154	0.432	-0.356	0.723
Country (NL)	0.272	0.215	1.265	0.212
Prior losses	2.898	0.607	4.772	0.000
Prior gains	2.324	1.250	1.859	0.070
Stdev/EV	-0.354	0.344	-1.029	0.309
Skewness	-0.167	0.447	-0.373	0.711
R-sq.	0.532			
Adj. R-sq.	0.471			

B. W=€50,000

	Coefficient	Standard error	t-statistic	p-value
Intercept	5.701	0.804	7.086	0.000
Age	0.362	0.653	0.554	0.582
Gender (f)	-0.875	0.709	-1.234	0.223
Education (h)	-0.154	0.837	-0.184	0.855
Country (NL)	-0.791	0.595	-1.330	0.190
Prior losses	10.186	1.679	6.067	0.000
Prior gains	-7.788	3.456	-2.254	0.029
Stdev/EV	-0.881	0.951	-0.927	0.359
Skewness	-1.678	1.236	-1.357	0.181
R-sq.	0.495			
Adj. R-sq.	0.429			

Table VII

Upper and lower RRA bounds

The table shows regression results for our sample of 53 "Deal or No Deal" episodes aired in Australia and the Netherlands in the years 2002 to 2005. In Panel A, the dependent variable is the lower RRA bound $\hat{\gamma}_i^L(W,b)$ for W=€25,000. In Panel B the dependent variable is the upper RRA bound $\hat{\gamma}_i^U(W,b)$ for W=€25,000.

A. Lower RRA bound $\hat{\gamma}_i^L(W,b)$

	Coefficient	Standard error	t-statistic	p-value
Intercept	1.846	0.460	4.011	0.000
Age	0.154	0.607	0.254	0.801
Gender (f)	-0.386	0.405	-0.952	0.346
Education (h)	-0.272	0.943	-0.289	0.774
Country (NL)	0.119	0.340	0.349	0.729
Prior losses	5.759	0.960	5.997	0.000
Prior gains	-2.009	1.977	-1.016	0.315
Stdev/EV	-0.451	0.544	-0.829	0.411
Skewness	0.096	0.707	0.136	0.893
R-sq.	0.470			
Adj. R-sq.	0.401			

B. Upper RRA bound $\hat{\gamma}_i^U(W,b)$

	Coefficient	Standard error	t-statistic	p-value
Intercept	5.311	0.772	6.881	0.000
Age	0.244	0.473	0.516	0.608
Gender (f)	-0.743	0.680	-1.093	0.280
Education (h)	-0.415	0.637	-0.651	0.518
Country (NL)	-0.670	0.571	-1.174	0.247
Prior losses	7.678	1.611	4.766	0.000
Prior gains	-3.779	3.316	-1.140	0.260
Stdev/EV	-0.842	0.913	-0.922	0.361
Skewness	-1.894	1.186	-1.597	0.117
R-sq.	0.435			
Adj. R-sq.	0.361			

Table VIII

Myopic and hyperopic framing

The table shows regression results for our sample of 53 "Deal or No Deal" episodes aired in Australia and the Netherlands in the years 2002 to 2005. The dependent variable is the estimated RRA for W=€25,000. Panel A considers the RRA computed using the "myopic distribution", i.e., the distribution of the bank offer in the next round, or the distribution of the prize that the contestant will take home if he or she decides "Deal" in the next round (myopia). In Panel B, the RRA is computed using the "hyperopic distribution", i.e., the distribution of the remaining prizes, or the distribution of the prize that the contestant will take home if he or she decides "No Deal" in all game rounds and plays the game to the end (hyperopia).

A. Myopic distribution

	Coefficient	Standard error	t-statistic	p-value
Intercept	3.578	0.531	6.736	0.000
Age	0.362	0.653	0.554	0.582
Gender (f)	-0.564	0.468	-1.206	0.234
Education (h)	-0.240	0.863	-0.278	0.782
Country (NL)	-0.275	0.393	-0.701	0.487
Prior losses	6.718	1.109	6.060	0.000
Prior gains	-2.894	2.282	-1.268	0.211
Stdev/EV	-0.646	0.628	-1.029	0.309
Skewness	-0.899	0.816	-1.102	0.276
R-sq.	0.506			
Adj. R-sq.	0.442			

B. Hyperopic distribution

	Coefficient	Standard error	t-statistic	p-value
Intercept	0.667	0.144	4.639	0.000
Age	0.344	0.563	0.611	0.544
Gender (f)	-0.107	0.127	-0.846	0.402
Education (h)	-0.362	0.635	-0.570	0.571
Country (NL)	0.108	0.106	1.017	0.314
Prior losses	2.416	0.300	8.054	0.000
Prior gains	-1.219	0.617	-1.974	0.054
Stdev/EV	-0.256	0.170	-1.506	0.139
Skewness	0.072	0.221	0.324	0.748
R-sq.	0.606			
Adj. R-sq.	0.554			

Table IX

Example "Frank"

The table shows the gambles presented to contestant Frank and the Deal/No Deal decisions made by him in round six to nine. This particular episode of the show was broadcasted on Dutch television on January 1, 2005. In round 9, Frank deliberately enters an "unfair" gamble by rejecting a bank offer of €6,000 or 120 percent of the expected prize.

Round	Remaining Prizes (€)					Exp. Prize (€)	Bank Offer (€)	Bank Offer (%)	Deal / No Deal
	0.50	10	20	10,000	500,000				
6	X	X	X	X	X	102,006	75,000	74%	No Deal
7	X	X	X	X		2,508	2,400	96%	No Deal
8		X	X	X		3,343	3,500	105%	No Deal
9		X		X		5,005	6,000	120%	No Deal
10		X				10	—	—	—

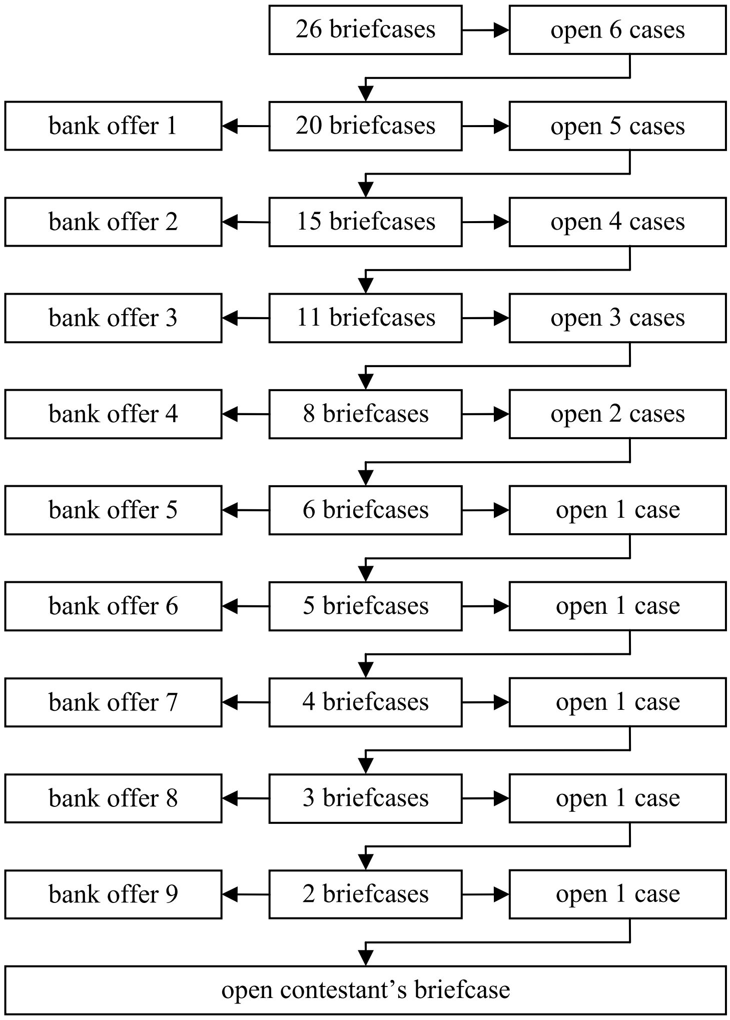


Figure 1: Flow chart of the main game. In every round, the finalist chooses a number of briefcases to be opened, each opened briefcase giving new information about the unknown prize in the contestant's own briefcase. After the prizes in the chosen briefcases are revealed, a "bank offer" is presented to the finalist. If the contestant accepts the offer ("Deal"), he or she walks away with the amount offered and the game ends; if the contestant rejects the offer ("No Deal"), play continues and he or she enters the next round. If the contestant decides "No Deal" in the ninth round, he or she receives the prize in his or her own briefcase.

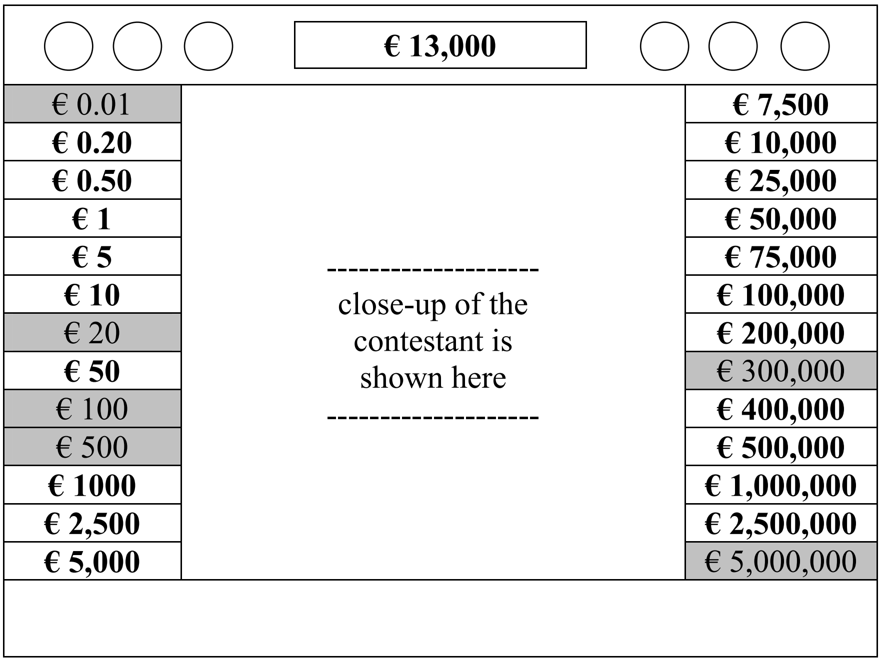
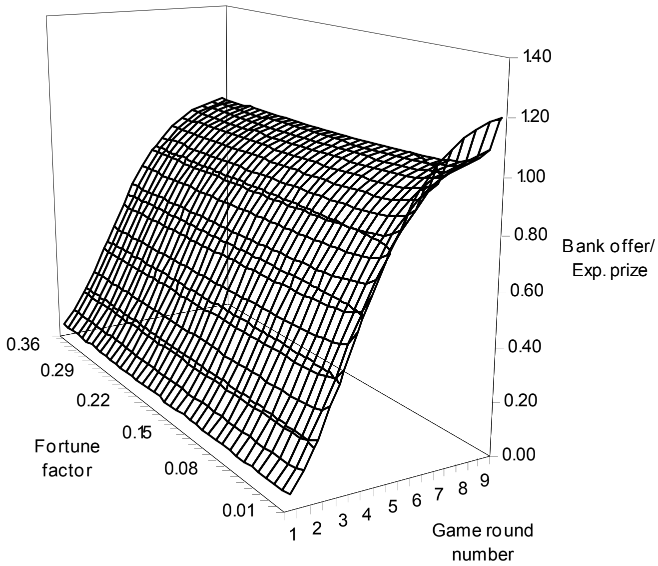


Figure 2: Example of main game as displayed on the television screen. A close-up of the contestant is shown in the centre of the screen. The possible prizes are listed in the columns to the left and right of the contestant. Prizes that are eliminated in earlier rounds are shown in a dark color and remaining prizes are in a bright color. The top bar above the contestant shows the bank offer. This example demonstrates the two options open to the contestant after opening six briefcases in the first round: accept a bank offer of €13,000 or continue to play with the remaining 20 briefcases, one of which is the contestant's own.

Panel A: Estimated Bank Function



Panel B: Goodness of fit

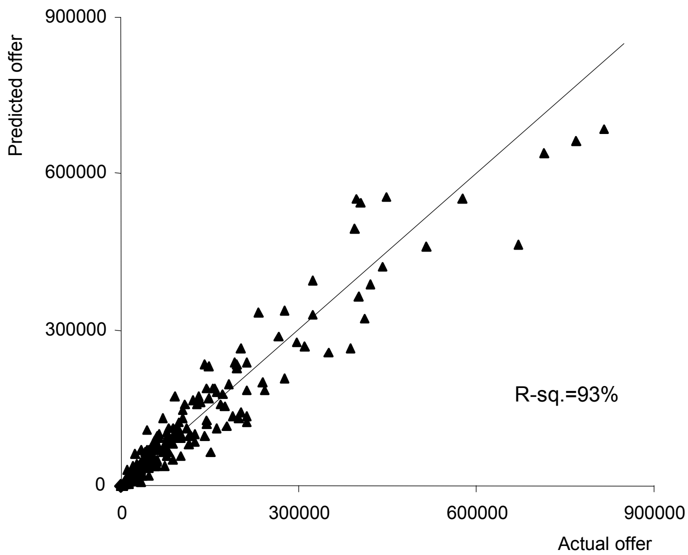


Figure 3: Estimated Bank Function. Panel A shows the estimated relationship between the bank offer as a fraction of the expected prize, the game round number and the fortune factor (current expected prize as a fraction of the initial expected prize). The parameters of the model $E[b(x_{i,r})] = E(x_{10}|x_{i,r})(1-\exp(\alpha_0 r^2))\exp(\alpha_1(for_{i,r}^{-1}-1))$, $i = 1,\cdots,I; r = 1,\cdots,9$, are estimated by minimizing the sum of squared errors in the full sample of all observed bank offers. The estimated values are $\hat{\alpha}_0 = -0.050$ and $\hat{\alpha}_1 = 0.002$. The relationship is shown only for low fortune values ($for_{i,r} \leq 0.36$), because the effect of fortune is minimal for higher values. Panel B shows the actual bank offers in Euros and the predicted bank offers.

Footnotes

[1] Game shows are also analyzed for purposes other than studying risk preferences and its determinants. For example, Levitt (2003) and Antonovics, Arcidiacono and Walsh (2005) analyze "The Weakest Link" to examine racial discrimination among contestants. List (2004) studies "Friend or Foe" to analyze the relationship between age and social preferences. Oberholzer-Gee, Waldfogel and White (2004) use data from the same game show to analyze cooperation in a prisoner's dilemma game. Finally, Bennett and Hickman (1993), Berk *et al*., (1996), and Tenorio and Cason (2002) examine "The Price Is Right" to study rational bidding and game theoretical aspects.

[2] Other examples are Argentina ("*Trato Hecho*"), France ("*A Prendre ou à Laisser*"), Hungary ("*Áll az alku*"), India ("*Deal Ya No Deal*"), Italy ("*Affari Tuoi*"), Mexico ("*Vas o no Vas*"), Spain ("*Allá Tú*"), Switzerland ("*Deal or No Deal - Das Risiko*") and Turkey ("*Trilyon Avı*"). Episodes in the US and the UK have also been announced.

[3] The elimination game may induce selection bias. For example, the quiz questions favor contestants with a relatively high level of general knowledge. Furthermore, to end of the Dutch elimination game, just before a last, decisive question, the two remaining contestants can avoid losing and leaving empty-handed by accepting a relatively small prize. Extremely risk averse contestants and/or contestants with a low level of general knowledge are most likely to accept this offer.

[4] The complete set of prizes for the Dutch episodes is shown in Figure 1. The average prize is €391,411. For the Australian shows in our sample the maximum is AU$2,000,000 and the average is about AU$155,000 (there is some time variation in the actual average due to minor changes in the small prizes).

[5] "*Miljoenenjacht*" actually started on November 25, 2000. However, the format of the first episodes is completely different from the later shows and involves no briefcases and bank offers. Rather, in these early shows, the contestant goes home with a prize that depends on the number of correct answers to a series of quiz questions.

[6] In fact, this series consisted of 14 episodes with a total of 16 contestants who played "Deal or No Deal". The unfinished games of four contestants were continued in the next episode and five episodes covered (parts of) the games of two or three contestants. In this study, we treat each game/contestant as a separate episode.

[7] Similar game options arise in other daily "small-stake" episodes. For example, the shows in Italy sometimes involve a "Change" option that allows the contestant to change his or her selected briefcase for a random other briefcase. This option is highly valuable, because the bank in these shows actually knows the selected prize and adjusts its offers accordingly. Thus, the bank offers have information content and if the bank offer is low compared with the expected prize, the contestant will chose to change.

[8] See http://members.iinet.net.au/~powney/gameshow/tradelist.php.

[9] When the amounts at stake become small, we may question if the contestant's decisions reveal his or her true preferences and beliefs. We therefore require a minimum expected prize of €1,000 to compute bounds to the contestant's RRA and put the upper bound equal to the lowest switching value for all rounds $r \leq R$-1 satisfying this minimum expected prize criterium.

[10] For contestants who play the game until the end (R = 10), $\hat{\gamma}_{i,R}(W,b)$ is not a lower bound, because these contestants never accept an offer. Also, in some exceptional cases, $\hat{\gamma}_{i,R}(W,b)$ is not uniquely defined, because the bank offer is larger than or equal to the largest remaining prize; in these cases, every rational contestant would choose to accept the bank offer, irrespective of his or her RRA. In these cases, we estimate the lower bound by the upper bound minus the average distance between the upper and lower bounds for the other contestants. This approach is also used when the expected prize in round R is smaller than €1,000.

[11] Over the period July 2003 – September 2004, the Australian Dollar showed only modest variation when measured against the Euro. The exchange rate ranged between €0.564 and €0.636.

[12] The tenth "round" is not included in the estimation, because the contestant then simply receives the prize in the single remaining briefcase. As in the RRA estimation procedure, we also exclude bank offers of game rounds with an expected prize less than €1,000.

[13] For contestants for which we had to estimate the lower bound, we simply used the fortune value from the round that was used to compute the upper bound, recognizing that the game round does not affect the expected prize (see Table I) and hence the expected value of the fortune variable.

[14] Recall that for the contestants who play the game to the end or who face an expected prize smaller than or equal to €1,000, the lower RRA bound is not estimated using information from an actual game round. Thus, for these contestants, the shape parameters are available only for the round used to compute the

upper RRA bound. The missing values associated with the lower bounds are set equal to zero; after all, the expected deviation from the average is zero.

[15] Apart from game show studies, the relative or absolute risk aversion coefficient has also been investigated using experimental studies (for example Binswanger, 1981, and Levy, 1994), field surveys (Barsky *et al*., 1997), portfolio allocation decisions (Friend and Blume, 1975) and macro data (see Kocherlakota, 1996, for a survey). Overall the findings are mixed, some studies find decreasing absolute or relative risk aversion, others increasing absolute or relative risk aversion. Also, the average estimated relative risk aversion coefficients are sometimes single digit, but also multiple digit coefficients are found.

[16] An alternative interpretation is that the gains and losses during the game simply are not integrated with the other components of lifetime wealth.

[17] According to Thaler and Johnson, this phenomenon should be especially relevant when decision-makers have the possibility to break-even on their earlier losses. Unfortunately, we cannot test this qualification here, because the shape of the distribution (apart from the mean) and the possibilities to recover from earlier losses are more or less constant for a given game round number, as discussed before.

[18] The argument is that wealthy individuals are not more risk-averse than poorer ones with regard to the same risk. Thus, as Arrow (1965) notes, DARA is necessary if risky assets are to be “normal goods”, i.e., a rise in wealth leads to an increase in demand for them, whereas IARA implies they are an “inferior good”.