Risk Aversion, Demographics and Unobserved Heterogeneity. Evidence from the Italian TV Show "Affari Tuoi"

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JEL Classification: C15, C33, C52, C93, D81

Keywords: choice under risk, natural experiment, demographic and unobserved characteristics

1. Introduction

Despite intensive research activity, there is still no clear consensus on the appropriate model of the behaviour of individuals when making choices under risk, though experiments, both laboratory and natural, have greatly contributed to the understanding of how individuals take risky decisions.

Television shows provide a good natural context in which ordinary people face well-defined decision problems in a *coeteris paribus* environment, and in which players have the benefit of salient incentives. Studies using such data are able to overcome both the Harrison and List (2004) and the Rabin (2000) critiques to experimental methods in economics, concerning the inferential validity of estimates based on the typical economic experiment, i.e. based on a non-representative sample and limited incentives provided by small money stakes.

Friend and Blume (1975), Gertner (1993), Metrick (1995) and Beetsma and Shotman (2001) measure individual risk attitude through television games in the US: Gertner (1993) and Friend and Blume (1975) obtained relatively high coefficients of risk aversion in data from the game *Card Sharks* and Beetsma and Shotman (2001) using data from the TV show *Lingo*; instead Metrick (1995) found risk neutrality using data from the game *Jeopardy!*

This paper aims at providing new evidence on risk aversion, while focussing on an aspect insufficiently developed thus far, namely subjects' heterogeneity. The relevance of this topic is twofold: from a theoretical point of view, by showing that differences among people significantly affects their decisions, we highlight the need for theoretical developments which can better account for diversity. From an applied viewpoint, the statistical significance of such individual factors allows us to provide better estimates than works disregarding this issue.

Because it is clear that different participants in the game differ in crucial characteristics, and hence in order to give our models sufficient flexibility to fit the data, we introduce heterogeneity terms both in the form of observable and unobservable individual characteristics. The former

includes everything concerning players that can be observed, like his or her gender, or geographic origin;[1] the latter involves all individual's characteristics that cannot be observed, such as his or her optimism or pessimism, cultural background, etc.

In order to identify the influence of the unobservable factors we require that several observations for each player are collected, and that these are handled with the instruments proper to panel data analysis. Much is known about the appropriate way to deal with panel data models,[2] even though introducing panel data in non-linear models causes more technical difficulties. We solve this problem using simulation techniques.[3]

We use data collected from from 298 showings of a well-known game broadcasted on the Italian television *Affari Tuoi* to estimate players' risk attitude as a function of observed and unobserved heterogeneity factors. *Affari Tuoi* is the Italian version of the popular international format *Deal or no Deal*, produced by Endemol.

The paper is structured as follows. In section 2, the basic rules of the television game are presented, with some references to the existing literature on other editions of *Deal or no Deal*; section 3 presents some descriptive statistics about our sample. Section 4 presents the econometric models to be estimated, while in section 5 the empirical results are presented. Section 6 concludes.

2. Game description

The Italian edition of *Deal or no Deal* exhibits some minor variations from the international format. Specifically, *Affari Tuoi* is developed as a 5-step stop-and-go game between a player and a Banker or Auctioneer. The game starts with 20 players, one from each of the 20 Italian regions. They are randomly assigned 20 sealed boxes, each containing a prize drawn from a know distribution (see Table 1). Boxes' contents range from € 0.01 to € 500,000: the average prize is € 52,545.83; the standard deviation of prizes is € 117,639.07; the distribution of prizes is highly skewed.

Table 1. *Prizes as displayed to players*

€ 0.01	€ 5,000
€ 0.20	€ 10,000
€ 0.50	€ 15,000
€ 1	€ 20,000
€ 5	€ 25,000
€ 10	€ 50,000
€ 50	€ 75,000
€ 100	€ 100,000
€ 250	€ 250,000
€ 500	€ 500,000

One player is selected to actually play the game by means of a funny question: the fastest candidate who answers correctly plays the game.[4] The game then proceeds as follows. In each of the 5 rounds, the player opens a fixed number of boxes (6 in the first round, 3 in the following), losing the possibility of winning the prizes contained therein. Between every two

[1] Harrison and Rutström (2005).

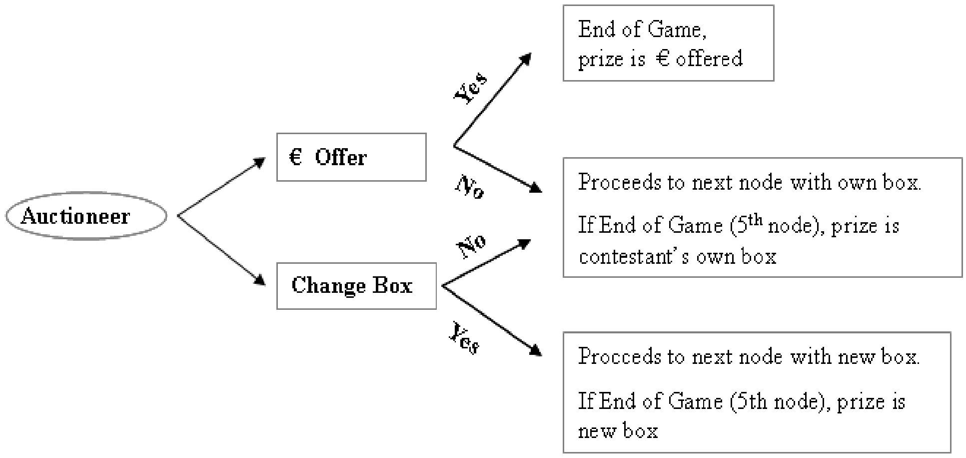
[2] Baltagi (2001) and Peracchi (2001).

[3] Gourieroux and Monfort (1996); Stern (2000); Train (2003).

[4] The questions are usually so naïve (e.g. the number of time the word "amore" appears in Dante's *Divina Commedia*) that no one can possibly answer but by chance. Hence, we will assume that players are randomly selected, though with a presumption of self-selection of the original 20 candidates of individuals keen of appearing on TV.

rounds, the Banker makes an offer: he either offers the player the opportunity to change her box with any of the remaining ones ("swap"), or he can offer a certain amount of money to the player to quit the game. If the player accepts the money, the game ends; otherwise she proceeds to the next round. If the player gets to the final round without having accepted any of the Banker's money offers, she wins the content of the box owned at that stage.

Figure 1. Typical decision round



As Andersen *et al.* (2006a, 2006b, 2006c) notice, three main estimation strategies have been developed to test hypotheses on behaviour under risk within *Deal or No Deal*. We briefly discuss them here.

The most simple method is to develop qualitative indicators which usually lead to scarce but definitive conclusions: for example, by comparing the money offer with the expected value of two remaining prizes at the last game round, risk-loving, indifference to risk, or risk-aversion can be inferred immediately. Many authors make this kind of analysis as a preliminary step to more structured estimations, and Blvatskyy and Pogrebna (2006a and 2006b) use qualitative indicators to formally test hypotheses.

Alternatively, it is possible to define a theory of behaviour which can lead to testable predictions, as a monotonic function of only one parameter. The typical example is to assume expected utility behaviour (EU), with CARA or CRRA functional forms, implying that the highest offer rejected, as a percentage of the continuation value of the game, sets a maximum value for individual's risk aversion, while the offer possibly accepted sets a minimum value. The advantage of this technique is that it allows individual-specific estimates, at the cost of providing only intervals of values, frequently not closed (for individuals who never accept the Banker's offers) and possibly empty (for individuals not behaving consistently according to the simple model of choice assumed). Henceforth, this method is employed in several works as a preliminary analysis of data (exception being Deck *et al.* (2006) and Post *et al.* (2006)). Bombardini and Trebbi (2005) extend this analysis to an interval regression of the estimated bounds, in order to investigate the role of possible sources of observed heterogeneity among contestants.

Finally, it is possible to define a latent structural decision process and estimate a logit or probit model as a function of the model's parameters. This is the approach followed by the present paper as well as by Andersen *et al.* (2006a, 2006b, 2006c), Mulino *et al.* (2006), Post *et al.* (2007), Sarafidis and de Roos (2006). Table 2 summarizes the most recent literature on the topic.

Table 2. Existing contributions to Deal or no Deal

	Andersen, Harrison, Igel Lau, Rutström (2006)	Bombardini and Trebbi (2005)	De Roos, Serafidis (2006)	Deck, Lee, Reyes (2006)	Mulino, Scheelings, Brooks, Faff (2006)	Post, Balthussen, Van dem Assem, Thaler (2007)
Sample	211, United Kingdom	252, Italy	399, Australia	52, Mexico	102, Australia	51 Netherlands, 47 Germany, 53 United States

Estimation Strategy	Probit	Interval Regression	Boundary Analysis, Probit	Boundary Analysis	Boundary Analysis, Logit	Probit
Theory of Behaviour	EU, RD, CPT	EU, CPT	EU, RD	EU	EU	EU, CPT
Functional Form	Expo-power	CRRA	CARA, CRRA	CARA, CRRA	CRRA	Expo-power
Wealth *	Estimated	0, ALI, ALIx10 (based on demographics)	0, ALI	0, ALI, "high"	ALI (based on postcode)	Estimated
Demogr.	No	Age, sex, region, employment and marital status, # children (partly imputed)	No	No	No, (age and gender for boundary analysis)	No
Unobserved Heterog.	No	No	Yes	No	No	No
Horizon	Static, Dynamic	Static, Dynamic	Static, Dynamic	1-step forward, Dynamic	Static, Dynamic	1-step forward
Expectations	Rational Expectations, stochastic	Rational Expectations, stochastic and deterministic	Rational Expectations, deterministic	Rational Expectations, stochastic	Rational Expectations, stochastic and deterministic	Rational Expectations, deterministic

Notes: for each reasearch group, only the latest paper is reported. Papers by Blvatskyy and Pogrebna (2006a and 2006b) on Italy's edition of DOND are not considered due to their different methodology and dataset.
* ALI = Average Labour Income.

We analyse players' answers and consider only the instances when the Banker makes a monetary offer, because the models of behaviour we consider would predict perfect indifference over changing box. In the flourishing literature on *Deal or No Deal*; Blvatskyy and Pogrebna (2006a and 2006b) consider also choices over the swap, on a subset of the Italian database.

We represent players' decisions as a choice between the Banker's offer and a lottery which consists in the possibility of winning any of the remaining prizes with equal probability. In other words, we assume that contestants behave myopically, in they consider the possibility of winning one of the remaining prizes in a subsequent node of the game, but they neglect the future Banker offers (or assuming these offers will equal prizes' expected value).[5]

3. The sample

In order to highlight the specifics of the Italian edition of the game, it is interesting to introduce the main characteristics of the observed sample. We monitored 298 matches curiously split between 149 men players and 149 women (we recall that players were selected by means of a quick close-answer quiz game). Contestants are less evenly divided on a geographical basis: we

[5] No clear consensus has been reached thus far in the literature on *Deal or No Deal,* on the validity of alternative hypotheses on players' myopia or on different degrees of forward-looking behaviour. Several attempts are made employing boundary analysis techniques, but this approach does not allow for measures of goodness of fit, thus impeding a formal comparison of estimates. The only attempt employing the estimation of a structural model, hence using the same methodology as our paper, is made by Sarafidis and de Roos (2006). They provide estimates of both a dynamic and a static model of players' behaviour using a database from the Australian edition of *Deal or no Deal*. They provide estimates of both the dynamic and the static model, but based on samples of different length, and therefore non-comparable.

record 115 players from Northern Italy, 75 from the Centre, 108 from the South, with a slight over-representation of women from Northern regions and men from Southern ones. Also, all regions are represented, ranging from 7 players from Calabria to 22 from Veneto. We do not discuss here on the representativeness of our sample, although we notice that sufficient variability in the sample is found, as to allow for the estimate of demographic covariates.

By comparing single showings, the mean of the Average Prize (AP) in each round proves considerably high and roughly stable until the fourth round (see Table 4), while the median AP is decreasing over game nodes. The standard deviation of AP shows an increasing trend, until it eventually becomes more than twice as high as the mean AP value. Hence, our sample is composed of rather unfortunate players, but with a great variance. Instead, due to the high variance of prizes at the beginning of the game, the variability of prizes within single shows decreases as the game develops: on average, it ranges from 208% of AP at first round, to 86% at the 5th, with absolute standard errors decreasing faster than mean AP. Initial prizes are very diverse in all the national editions of *Deal or no Deal*, and Post *et al.* (2007) interpret this evolution as a decreasing complexity of the lottery involved.

Only 4 players quitted the game at the second round, 12 at the third, 79 and 53 at fourth and fifth. On average, the average winnings are 31,158.63 euros, with a standard deviation of € 56,396.14. That is, players win on average less than the game's *a priori* expected value. Players' winnings grow with the number of rounds played, as confirmed by their mean and median values per round. The only exception is represented by the last round when contestants refuse the Banker's offer. At every round, winnings' standard deviation are smaller than the AP's, but increasing.

Summarizing, our sample exhibits: i) decreasing average values of prizes; ii) increasing variability of prizes among players, but not along game rounds; iii) increasing winnings in game roounds (exception being the case of refusal of the last offer). In our sample, the longer the game proceeds, the higher are the final prize and the risk implied.

No significant differences emerge between men's and women's winnings (their means are respectively € 29,155.44 and € 33,161.81, and standard deviations € 53,567.50 and € 59,202.89). Winnings differ instead across geographical areas: contestants from Northern regions perform more closely to the average values of the sample; players from Central regions win less than the average, with a smaller spread (mean € 24,762.32 and standard deviation € 37,731.70); the mean and the standard deviation of the winnings for players from the Southern regions are respectively € 38,176.60 and € 77,550.05, both higher than the average value of the sample.

Table 3. Descriptive Statistics

Average Prize		*Mean*	*Std. Dev.*	*Median*
	Round 1	52,083.27	18,040.43	55,393.62
	Round 2	52,611.53	23,854.52	53,944.36
	Round 3	52,134.2	33,218.37	46,910.18
	Round 4	50,664.48	46,185.59	29,100
	Round 5	41,092.12	69,307.32	12,500.05
Final Prize				
	Round 2	16,000	8,485.281	16,000
	Round 3	18,125	8,361.505	16,000
	Round 4	25,653.41	16,119.17	25,000
	Round 5	45,212.98	51,143.8	30,000
	End	29,721.68	77,197.32	250
	Average	31,158.63	56,396.14	15,000
	Women	33,161.81	59,202.89	15,000
	Men	29,155.44	53,567.5	17,000

	North	28,691.77	41,783.91	15,000
	Centre	24,762.32	37,731.7	13,000
	South	38,176.6	77,550.05	20,000

In Table 4 the history of players' choices is summarized: it is clearly shown how, as a rule, contestants are given the chance to choose the box they will own after the first node.

Table 4. Descriptive Statistics

Number of Observations

	Players	*Swap Offer*	*Acceptance*	*Money Offer*	*Mean*	*Std.Dev.*	*Acceptance*
Round 1	298	293	72	5	€ 3,200	€ 1,351	0
Round 2	298	9	4	289	€ 6,584	€ 6,584	4
Round 3	294	33	12	268	€ 7,790	€ 7,790	12
Round 4	284	37	9	251	€ 16,388	€ 16,388	80
Round 5	204	96	40	109	€ 32,844	€ 49,304	54

4. The EUT choice model

We assume that utility for player i is defined by a classical Constant Absolute Risk Aversion (CARA) preference functional,[6]

$$U_i(x) \quad \frac{\exp(\; R_i \; x)}{R_i}, \tag{1}$$

where x is the lottery price and R_i is the individual-specific risk attitude parameter.

During the game, players are confronted with binary choices between a lottery, where they can win with equal probability, one of the left boxes, and a degenerate lottery where they can win with probability 1 the amount of money offered by the Banker. The game is made of 4 rounds, indicated by n, n=1,…,5.

Let EU_{in} be the expected utility of the lottery in round n for player i, that is the probability weighted utility of each outcome left in round n,

$$EU_{in} \quad \underset{k_n}{} p_{k_n} \; U_i(x_{k_n}), \tag{3}$$

where p_{k_n}, with $k_n = 1,\ldots,K_n$, is the probability of the outcome k in round n.

[6] The utility functional is appropriately normalized, such that $U_i(0)=0$ and $U_i(max(x))=1$. We also run all the estimations assuming CRRA and Expo-power functionals, assuming a non-zero wealth level to be estimated as a parameter of the model. We do not report the corresponding results because they systematically fit the data worse than the CARA specification, and provide no different economic insights.

Let $U_i(off_n)$ be the utility of the amount offered to player i in round n by the Banker.

Player i chooses between playing the lottery or accepting the offered amount the option that maximizes the difference

$$U_{in} \quad EU_{in} \quad U_i(off_n) \quad {}_{in}, \tag{4}$$

where ${}_{in}$ is a Fechner-type error term (Hey and Orme, 1994), with ${}_{in} \sim N(0, \sigma_\epsilon^2)$. It can be seen as a computational error in calculating utilities: the larger σ_ϵ^2, the greater the computational error.

Actually, what we observe is the variable $U_{in} = 1$ if individual i in round n prefers the lottery, otherwise $U_{in} = 0$ if individual i in round n prefers the offer. The model is then described by:

$$\begin{aligned} U_{in} \quad 1 \quad &\text{if} \quad U_{in} \quad 0 \\ U_{in} \quad 0 \quad &\text{if} \quad U_{in} \quad 0. \end{aligned} \tag{16}$$

Each game is composed of several binary choices, such that for each player we observe a sequence of 0 and 1, corresponding to players' choices at each stage of the game. Then, the likelihood contribution of player i is the joint probability of observing the sequence of outcomes ($U_{i1}, \ldots, U_{iN}$),

$$L_i \quad f(\quad U_{i1}, \quad , \quad U_{iN} | X_i, R_i), \tag{7}$$

where X_i represents the sequence of lottery prices in player i's game. To handle this joint probability we need to make assumptions on the error term ${}_{in}$ and on the independence of observations. In effect, as our sample contains repeated observations on the same player, we cannot discard the hypothesis that these observations are correlated. In a linear random-effects panel data model, this situation is generally handled by introducing an individual-specific intercept in the model, referred to as unobserved heterogeneity, which is assumed to have a particular distribution across individuals. What is left of the error term is therefore independent of everything else in the model. In contrast, our latent dependent variable is non-linear in the parameters to be estimated. In this case, to control for individual correlation we have at least two options: 1) assume that the unobserved heterogeneity is part of the Fechner-type error term (so that this component can be perceived as contestant i systematically overvaluing or undervaluing the difference between the expected utility of the lottery and the utility of the Banker's offer); 2) assume that there is a systematic individual-specific component in the risk aversion parameter that is normally distributed across the population:

$$R_i \qquad z_i \quad u_i^s. \tag{7}$$

Here a constant and u_i^s reflects unobserved heterogeneity, with $u_i^s \quad N(0, \sigma_u^2)$, such that $R_i \quad N(\alpha + z'_i \beta, \sigma_u^2)$.

After controlling for the unobserved heterogeneity in one of these two ways, we are allowed to assume that ${}_{in}$ are independently and identically distributed, with ${}_{in} \sim N(0, \sigma_\epsilon^2)$, and independent of everything else. Our choice falls on the second option

because we want to capture the heterogeneity of players' risk attitude highlighted by other studies about Deal or No Deal.[7] This specification allows us to estimate the distribution of the risk attitude parameter across the population. Such a distribution has a mean that varies with the demographic characteristics of the player and a variance that accounts for the spread of the risk attitude across the population.

As we assume that all $_{in}$ are independent over choices, we can write this joint probability as

$$L_i \quad f(\quad U_{i1},\ldots, \quad U_{iN}|X_i, z_i, \quad)$$

$$f(\quad U_{i1},\ldots, \quad U_{iN}|X_i, z_i, \quad , u_i^s)\frac{1}{\quad}_{u} \quad \frac{u_i^s}{\quad}_{u} \; du_i^s \qquad (8)$$

$$[\quad_{n} \quad f(\quad U_{in}|X_i, z_i, \quad , u_i^s)\frac{1}{\quad}_{u} \quad \frac{u_i^s}{\quad}_{u} \; du_i^s$$

We also allow for the possibility of sub-optimal behaviours, introducing a tremble parameter, *w*, that measures the probability that players choose completely at random in some of their choices.[8] It accounts for a concentration mistake, that is we take into account the possibility that players loose concentration somewhere in the game. The tremble parameter goes to zero if players behave optimally; on the contrary, it goes to 1 if their choices are completely random. With this parameter the last line of eq. 8 becomes

$$\{ \quad_{n} \quad [(1 \quad)f(\quad U_{in}|X_i, z_i, \quad , u_i^s) \quad \frac{\quad}{2}]\}\frac{1}{\quad}_{u} \quad (\frac{u_i^s}{\quad}_{u})du_i^s . \qquad (9)$$

Finally, we maximise the total log-likelihood

$$\log L = \sum_{i=1}^{298} \ln L_i \; . \qquad (10)$$

by maximum simulated likelihood. We use simulation techniques because the Gauss-Hermite quadrature is extremely computationally intensive in our case, and there are simulation techniques like the Halton sequences we use here that reduce the computational burden of the estimation.

5. Econometric results

To estimate players' risk attitude and to study the determinants and the extent of observed and unobserved heterogeneity, several different model's specifications are estimated, including the explanatory variables listed in Table 5. Five of these models are reported in Tables 6 and 7.[9] Table 6 shows the simplest specifications of the model, without unobserved heterogeneity, as well as another specification obtained by adding the

[7] See, among the others, Bombardini and Trebbi (2005).

[8] Loomes, Moffatt, and Sugden, 2002.

[9] The other results are available from the authors upon request.

demographic dummies. Table 7 lists some specifications of the model with unobserved heterogeneity, differently combined with the demographic variables.

Table 5. *Description of the variables included in the analysis*	
unobserved heterogeneity	37250 (125 per player) random draws from a standard normal density obtained through a Halton sequence
dummy sex	dummy variable taking the value of 1 if the player is a male, 0 otherwise
dummy north	dummy variable taking the value of 1 if the player is from the North of Italy, 0 otherwise
dummy south	dummy variable taking the value of 1 if the player is from the South of Italy, 0 otherwise

The last line of Tables 6 and 7 provide the negative log-likelihood values. We use these values to check for the improvement in the likelihood function of an unrestricted model over a more parsimonious one, and to determine the improvement in the fitting of nested models. Likelihood ratio tests are performed for all nested models, the most significant are reported in Table 8. Under the null hypothesis, the statistic has a Chi-squared distribution with degrees of freedom equal to the number of restrictions.

All the specifications in Table 6 are estimated by maximum likelihood. It emerges that , the constant component of the risk aversion parameter, is positive and statistically significant under all the specifications of the model, highlighting players' risk aversion. Also, its value does not vary considerably when new variables are added. All demographic dummies are not statistically significant at a reasonable significance level, and the log-likelihood is unchanged by the addition of these variables.

Table 6. Probit model - Maximum likelihood results (observations 923, groups 298)

	(1)	(2)
	0.01087 (0.00052)	0.00979 (0.00102)
dummy sex		0.00000 (0.00103)
dummy north		0.00133 (0.00121)
dummy south		0.00172 (0.00128)
σ_ϵ	0.05870	0.05731

	(0.00471)	(0.00485)
w	0.05180 (0.00013)	0.05652 (0.00016)
log-likelihood	-310.43394	-310.33925
Standard errors in parentheses		

Table 7 reports specifications including unobserved heterogeneity: all the models are estimated by maximum simulated likelihood.[10] To introduce unobserved heterogeneity in our model we used 37,250 random draws (125 per player) from a standard normal density obtained through a Halton sequence based on primes.[11]

The unobserved heterogeneity parameter seems to play a very important role in all the specifications, as its standard deviation is always quite high, relatively to the mean of the risk aversion parameter. The estimated constant component of the mean of the risk attitude parameter, , is still positive and strongly statistically significant in all specifications, but its magnitude varies considerably depending on the covariates included in the specification. Specifically, the parameter is increased by the introduction of unobserved heterogeneity, while it returns to levels comparable to those reported in Table 6 when adding geographical dummies.

Most notably, the constant term is substantially lowered by the introduction of unobserved heterogeneity and the full set of demographic covariates: it reduces of almost a half if the dummy sex is introduced in the estimation. The demographic dummies denoting geographical origin are never found statistically significantly different from zero; the dummy sex is statistically significant at the 5% level when introduced jointly with the unobserved heterogeneity term and the other demographic dummies. The constant term is lowered by its introduction, and the dummy sex coefficient is significantly greater than zero, showing that in our sample risk aversion is higher for men than for women, contrarily to the most part of evidence on gender risk attitude in experiments.[12]

Table 7. Random effect probit model - Maximum simulated likelihood results (observations 923, groups 298)			
	(3)	(4)	(5)
	0.01148 (0.00091)	0.01062 (0.00273)	0.00654 (0.00249)
	0.00882 (0.00110)	0.00882 (0.00110)	0.00865 (0.00104)
dummy sex			0.00419 (0.00184)

[10] See, for example, Gourieroux, C. and A. Monfort (1996).

[11] Halton sequences is a variance reduction tool to take random draws from a density function. These draws are shown to have a self-correcting property over observations. Such a property performs better when the number of random draws for observation is low (about 100), relatively to other simulation techniques. Further details are found in Train, K. (2003).

[12] Schubert, R., Brown M., Gysler M. and H. W. Brachinger (1999).

dummy north		0.00099 (0.00300)	0.00305 (0.00247)
dummy south		0.00095 (0.00327)	0.00334 (0.00273)
σ_ϵ	0.03951 (0.00622)	0.03936 (0.00627)	0.03919 (0.00587)
w	0.00364 0.00009)	0.00364 (0.00011)	0.00364 (0.00012)
log-likelihood	-94.24548	-94.18431	-93.46472
Standard errors in parentheses			

Likelihood-ratio tests show that all the specifications including unobserved heterogeneity (table 7) fit substantially better than those not including that variable.
According to likelihood-ratio tests, specification (3), including only the constant and unobserved heterogeneity, fits relatively better than specifications (4) and (5), containing the demographic variables. Hence, adding unobserved heterogeneity leads to a significant improvement of fit in all instances, whereas further covariates, such as demographic variables, seem not to give an improvement in the fitting which justifies the lost in parsimony of the model. As a general result, we find that more complex models are always rejected in favour of the most parsimonious ones, provided that they include unobserved heterogeneity.

Table 8. Comparing alternative specifications of the model

Competing specifications	*Likelihood-ratio test statistic*
1. specification (3) v/s specification (1)	432.67392 (χ^2_1)
2. specification (4) v/s specification (3)	0.12234 (χ^2_2)
3. specification (5) v/s specification (3)	1.56152 (χ^2_3)
The distribution of the test statistic under the null hypothesis is reported in brackets.	

6. Conclusions

We use data from 298 showings of the television programme "Affari Tuoi", which involves players taking decisions between risky prospects with outcomes up to half a million euros, to estimate a models of decision making under risk assuming that players are expected utility maximiser.

Interestingly, in contrast with the prevailing experimental literature, we find that the CARA specification fits significantly better than the conventionally-adopted CRRA specification and also of the more general Expo-power specification.

We take into account both observed and unobserved heterogeneity in players' attitude to risk. The latter allows us to obtain not just a point-estimate, but the whole distribution of the risk attitude parameter over the population. Crucially, we find that unobserved heterogeneity plays a significant role, implying that our estimates provide superior estimates of risk attitude than other studies. It actually does not seem to significantly influence the mean of the risk aversion parameter, but the fitting of the model significantly improves according to likelihood-ratio tests.

As far as observed heterogeneity is concerned, the only relevant demographic variable seems to be *dummy sex*. Interestingly, this dummy variable shows that in our sample the mean of the risk attitude parameter is higher for men than for women, contrarily to the most part of the evidence on gender risk attitude in experiments.

Overall, the introduction of the unobserved heterogeneity reduces significantly the standard deviation of the Fechner-noise error term. This means that, after controlling for heterogeneity in players' risk attitude, almost nothing is left to the error term to be explained.

The estimates of the tremble parameter show that just a small proportion of players choose completely at random in their choices. Its magnitude is close to 5% in the specification without unobserved heterogeneity, but it reduces to 0.3% when unobserved heterogeneity is included.

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