

**RISK AVERSION, DEMOGRAPHICS AND UNOBSERVED  
HETEROGENEITY. EVIDENCE FROM THE ITALIAN TV SHOW  
“AFFARI TUOI”**

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## **1. Introduction**

The analysis of individual choices under risk and uncertainty are still lacking of a complete set of theory assessments that permit to explain individual choices and real world behaviours. Experiments greatly contributed to the debate among different theoretical framework giving support to better understand how risk aversion, gender, learning in repeated choices or strategic behaviours, may affect individuals' decisions. However the experimental evidence is sometimes flawed by the fact that incentives in place are not adequate and by the fact that the context adopted is artificial and far away from reality. This gave rise to a number of critiques among which the well known Rabin critique<sup>1</sup> that assesses that the utility function presents different shaping depending on the relevance of the monetary gamble involved and therefore given the range of laboratory incentives experimental results are lacking to take into account of this possibility. Moreover, Harrison and List<sup>2</sup> pointed out that experiments conducted in the lab involve non representative subject pools.

For this reason more and more attention has been drawn to the so called “natural experiments”. Television game shows provide a precious opportunity for economists since they are structured so that participants face well-defined decision problems, often presented as strategic games. Therefore even if the results they produce have to be carefully controlled in order to establish the

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<sup>1</sup> Rabin, M. (2000), “Diminishing marginal utility of Wealth cannot explain Risk Aversion”, in D. Kahneman - A. Tversky eds., *Choices, Values, and Frames*, Cambridge, Cambridge University Press.

<sup>2</sup> Harrison, G. W., and J. List (2004) “Field experiments”, *Journal of Economic Literature*, 42, 1009-55.

necessary level of clearness (that is of motivation and rules of the game), they can be used as a fruitful source of information.

Friend and Blume, Gertner, Metrick and Beetsma and Shotman<sup>3</sup> measure individual risk-attitude through television games in the US: Gertner and Friend and Blume obtained relatively high coefficients of risk aversion in data from the game *Card sharks* and Beetsma and Shotman using data from the TV show *Lingo*; instead, Metrick found risk neutrality using data from the game *Jeopardy!*

The aim of this paper is to use data collected from 298 shows of a well known game broadcasted on the Italian television, whose name is “Affari tuoi”, to estimate the preference functional of the players, which we assume to be a function of demographic variables, time and unobserved heterogeneity. We start assuming that the preferences are Expected Utility preferences and we estimate the risk aversion parameter of the players. We can test whether these preferences are stable through the show, or whether they change as the show progresses. We can also discover how risk attitude depends upon demographics and unobserved heterogeneity.

As far as the rules of the game are concerned, *Affari Tuoi* is a 5 step interactive game between a player and an auctioneer. The game starts with 20 players, one coming from each of the Italian regions. There are 20 boxes containing the following prizes (expressed in Euros):

0.01, 0.2, 0.5, 1, 5, 10, 50, 100, 250, 500,  
5000, 10000, 15000, 20000, 25000, 50000, 75000, 100000, 250000, 500000.

Each of the 20 boxes are randomly assigned to the 20 players.

In each game one of the players is randomly selected and plays against the auctioneer. The player first opens six of the boxes assigned to the other players, losing the possibility to win the prices contained therein. At this point, the auctioneer either offers the player the opportunity to change his box with one of the remaining boxes, or offers the player an amount of money (which the auctioneer decides). If the player accepts the money, the game ends. Otherwise, he or she goes on with the game. There are four further potential rounds, in each of which the player opens three more boxes and the same procedure is repeated. If the player gets to the final round without having accepted any offer of the auctioneer, the player wins the contents of the box that he has at that point.

The database we use in this work relies on two different blocks broadcasted in TV from the beginning to June 2nd 2005, for a total 298 shows.

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<sup>3</sup> Friend, I., and Blume M. B. (1975), “The demand for risky assets”, *American Economic Review*, 65, 900-922; Gertner, R. (1993) “Game shows and economic behaviour: risk taking on “Card sharks””, *The Quarterly Journal of Economics*, 108, 507-521.; Metrick, A. (1995), “A natural experiment in “Jeopardy!””, *The American Economic Review*, 85, 240-253; Beetma, R. and Shotman, P. (2001), “Measuring risk attitudes in a natural experiment: data from the television game show Lingo”, *The Economic Journal*, 111, 821-848.

## 2. Heterogeneity

As far as our analysis is concerned, heterogeneity is all omitted and unmeasurable variables in a individual's choice process, such as habits, demographics, optimism or pessimism, etc.

It is important to include heterogeneity when modelling choice processes econometrically, because the other variables account for only part of the explained variance individual's choice. If not controlled for, heterogeneity factors are absorbed by the error term. This may badly bias results, leading to wrong inferences.

The potential sources of heterogeneity can be divided in two groups: observed heterogeneity and unobserved heterogeneity factors. Observed heterogeneity include all that factors concerning the player that can be observed, like his gender, and his geographic origin; these variables can be observed and included in the analysis. Moreover, unobserved heterogeneity involves all the individual's characteristics that cannot be observed, like his behaviour, optimism or pessimism, his cultural background, etc. Nonetheless, adding unobserved heterogeneity to our analysis would allow for a richness strongly necessary to explain data.

Much is known about the way to deal with unobserved heterogeneity in linear panel data models<sup>4</sup>. Introducing unobserved heterogeneity in non-linear models induces more technical difficulties. In the last decades this problem has been solved by using simulation techniques<sup>5</sup>.

In synthesis, in the random effects model unobserved heterogeneity is considered as an individual-specific component assumed to be distributed over the population according to some distribution function. Then, as an individual's unobserved heterogeneity can be thought as a random draw from a distribution function, simulated draws from the distribution of interest can replace these random draws<sup>6</sup>.

## 3. The model

We assume that utility for player  $i$  is defined by a classical Constant Absolute Risk Aversion (CARA) preference functional<sup>7</sup>,

$$U_i(x) = -\exp(-R_i \cdot x), \quad (1)$$

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<sup>4</sup> See, for example, Peracchi, F. (2001) *Econometrics*, John Wiley & Sons, Chichester.

<sup>5</sup> Stern, S. (2000) "[Simulation Based Inference in Econometrics: Motivation and Methods.](#)" in *Simulation-Based Inference in Econometrics: Methods and Applications*, eds., [Roberto S. Mariano](#), [Melvyn Weeks](#), and [Til Schuermann](#), Cambridge University Press.

<sup>6</sup> See, for example, Train, K. (2003) *Discrete choice methods with simulation*, Cambridge University Press; and Gourieroux, C. and A. Monfort (1996), *Simulation-Based Econometric Methods*, Oxford University Press.

<sup>7</sup> The utility functional is appropriately normalized, such that  $U_i(0)=0$  and  $U_i(\max(x))=1$ .

where  $x$  is the lottery price and  $R_i$  is the risk attitude parameter. We also assume that  $R_i$  is composed of several elements:

$$R_i = \alpha + z_i' \cdot \beta + \sigma \cdot u_i^S, \quad (2)$$

where  $\alpha$  is a constant,  $z_i$  is a vector of observed demographic characteristics and  $u_i^S$  reflects unobserved heterogeneity, with  $u_i^S \sim N(0,1)$ . This specification allows for heterogeneous preferences across individuals. This means that players' risk attitude is normally distributed around the population average that depends on demographics, i.e.  $R_i \sim N(\alpha + z_i' \beta, \sigma^2)$ .

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 auctioneer. The game is made of 5 rounds, indicated by  $n, n=1, \dots, 5$ .

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  $n$ ,

$$EU_{in} = \sum_{k_n} p_{k_n} \cdot U_i(x_{k_n}), \quad (3)$$

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

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

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

$$\nabla U_{in}^* = EU_{in} - U_i(off_n) + \nu \cdot \varepsilon_{in}, \quad (4)$$

where  $\nu \cdot \varepsilon_{in}$  is a idiosyncratic error term and  $\nu$  is a scale parameter<sup>8</sup>. We assume that  $\varepsilon_{in}$  are independent of each other and of observed ( $z_i$ ) and unobserved ( $u_i^S$ ) characteristics of the model and finally that they are also identically distributed  $N(0,1)$ . Such that,  $\nabla U_{in}^*/\nu$  is also normally distributed.

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

$$\begin{aligned} \nabla U_{in}^* &= EU_{in} - U_i(off_n) + \nu \cdot \varepsilon_{in}, \\ \nabla U_{in} &= 1 \quad \text{if} \quad \nabla U_{in}^* > 0 \\ \nabla U_{in} &= 0 \quad \text{if} \quad \nabla U_{in}^* \leq 0. \end{aligned} \quad (6)$$

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<sup>8</sup> The scale parameter is necessary because of the normalization of the utility function operated. See footnote 6.

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  $(\nabla U_{i1}, \dots, \nabla U_{iN})$ ,

$$f(\nabla U_{i1}, \dots, \nabla U_{iN} | X_i, z_i, \alpha), \quad (7)$$

where  $X_i$  represents the sequence of lottery prices in player  $i$ 's game.

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

$$\begin{aligned} f(\nabla U_{i1}, \dots, \nabla U_{iN} | X_i, z_i, \alpha) &= \\ \int_{-\infty}^{+\infty} f(\nabla U_{i1}, \dots, \nabla U_{iN} | X_i, z_i, \alpha, \varepsilon_i^S) \phi(\varepsilon_i^S) d\varepsilon_i^R &= \\ \int_{-\infty}^{+\infty} \left[ \prod_n f(\nabla U_{in} | X_i, z_i, \alpha, \varepsilon_i^S) \right] \phi(\varepsilon_i^S) d\varepsilon_i^R. & \end{aligned} \quad (8)$$

We also allow for the possibility of sub-optimal behaviours, introducing a tremble parameter,  $w$ . It measures the probability that players “tremble” in some of their choices<sup>9</sup>:

$$w = 1 / (1 + \exp(\tau)), \quad (9)$$

where  $\tau$  is a parameter to be estimated. The tremble  $w$  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:

$$\int_{-\infty}^{+\infty} \left\{ \prod_n \left[ (1-w) f(\nabla U_{in} | X_i, z_i, \alpha, \varepsilon_i^S) + \frac{w}{2} \right] \right\} \phi(\varepsilon_i^S) d\varepsilon_i^R. \quad (10)$$

## 5. Econometric results

The sample is composed of 298 observations (149 female and 149 male players). In the whole sample, 39% of players are from the North of Italy (62 men and 53 women), 25% from the Centre (respectively, 36 and 39) and 36% from the South (respectively, 51 and 57).

As described in table 1, to control for demographics (observed heterogeneity) we use 3 dummies: *dummy sex* that takes the value of 1 if the player is a male, 0 otherwise; *dummy north* and *dummy south* that takes the value of 1 if the player is respectively from the North or from the South of Italy, 0 otherwise. We also use a time dummy variable, *5<sup>th</sup> round dummy*, taking the value

<sup>9</sup> See Loomes G., P.G. Moffatt, and R. Sugden, 2002, “A microeconomic test of alternative stochastic theories of risky choice”, *Journal of Risk and Uncertainty*, 24, 103-130.

of 1 if the decision is taken in the fifth round. With such a variable we want to take into account the possibility that in early rounds players are less likely to accept the offer, *ceteris paribus*, just because they want themselves to be watched on TV. This dummy takes also into account the framing effect generated in early rounds when players face not a one-shot lottery, but a sequence of nested lotteries.

To estimate players' risk attitude parameter and to study the determinants and extent of observed and unobserved heterogeneity, several different model's specifications are estimated, including the explanatory variables listed in table 1. Only 10 of them, the most relevant, are reported in table 2 and 3<sup>10</sup>. Table 2 shows the simplest specification of the model without unobserved heterogeneity and other specifications obtained by adding, one at a time and jointly, both *5<sup>th</sup> round dummy* and demographics. Table 3 lists several specifications of the model with unobserved heterogeneity, differently combined with demographics and the *5<sup>th</sup> round dummy*.

Finally, likelihood ratios are estimated and the improvement in fit due to added variables is determined. The last line of table 2 and 3 provides the negative log-likelihood values. This can be used to check the improvement in the likelihood value of an unrestricted model over a more parsimonious one. This way it is possible to determine the improvement in fit of models which are nested within ones less restricted.

Likelihood ratio tests are performed for all nested models (table 4 only reports likelihood-ratio tests for the most relevant couples of nested specifications of the model). 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 2 are estimated by maximum likelihood technique. The results in that table, which includes all the specifications without unobserved heterogeneity, show  $\alpha$ , the constant component of the risk aversion parameter, to be positive and highly significant whatever the specification is. Its value does not vary considerably depending on the variables included in the specification. Such a result indicates that players are risk adverse. The variable controlling for the framing effect, *5<sup>th</sup> round dummy*, is also strongly significant and its coefficient is more than 2 times bigger than the constant component. This suggests that players feel a strong framing effect due to the characteristics of the lottery they are confronted with during the game and become more risk adverse as the game goes by. In effect, only in the 5<sup>th</sup> round they actually get the content of their box, if they choose to play the lottery instead of the amount of money offered by the auctioneer. In early rounds, if players choose the lottery, they do not win the prize of their box but they only get the opportunity to open a certain number of left boxes that will be excluded from the game. Specifications (2) and (4) of the model include observed demographic variables. Except for a slightly statistical significance of the *dummy south* in specification (4), the others (*dummy sex* and *dummy north*) seem not to play any role in explaining players' risk attitude. Likelihood ratio test statistics, reported in table 4, strongly reject the null

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<sup>10</sup> In order to preserve space, only the most relevant results are reported. Other results are available from the authors upon request.

that there are no framing effects (specifications (3) and (4) v/s specification (1)). Nonetheless, we cannot reject the null hypothesis that restrictions on demographic variables implied by specification (3) v/s specification (4) are correct.

In table 3 all the specifications include unobserved heterogeneity. To introduce unobserved heterogeneity in our model we used 37250 random draws (125 per player) from a standard normal density obtained through a Halton sequence based on primes<sup>11</sup>. All the specifications in the table are estimated by maximum simulated likelihood technique<sup>12</sup>.

The estimated constant component of the risk attitude parameter of the model,  $\alpha$ , is still positive and strongly statistically significant in all specifications. The magnitude of the estimated parameter vary considerably depending on the covariates included in the specification. It reduces of almost a half, if dummy sex is involved in the estimation. Also the unobserved heterogeneity parameter seems to play a very important role in all the specifications. The value of its coefficient is always quite high, relatively to the estimated  $\alpha$ . This means that risk attitude parameter is normally distributed with mean equal to estimated  $\alpha$  and variance equal to the square of the estimated unobserved heterogeneity parameter. This result suggests that players in the sample at hand are on average risk adverse, but not unlikely strongly risk adverse or risk neutral and even moderately risk loving. Demographic variables seem not to play any role in all of the specifications, except for the coefficient on *dummy sex* that is different from zero at the 5% level in the specification (7). This result suggests that men are more risk adverse than women, contrarily to the most part of the evidence on gender risk attitude in experiments<sup>13</sup>.

Likelihood ratio tests show that all the specifications including unobserved heterogeneity (table 3) fit definitely better than the ones in table 2 not including that variable.

According to likelihood ratio tests, specification (5), involving only a constant and unobserved heterogeneity, fits better than specifications (6) and (7) containing the demographic variables. It also provides a better fit than specification (8) with the *5<sup>th</sup> round dummy*, and than specification (9) and (10) with both *5<sup>th</sup> round dummy* and demographic variables. This means that adding unobserved heterogeneity leads to a significant improvement in fit in all instances, but further covariates, like demographic variables and a framing effect (*5<sup>th</sup> round dummy*), seem not give any improvement in fit. In effect, according to likelihood ratio test statistics, we can never reject the null hypotheses that restrictions in

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<sup>11</sup> Halton sequences is a variance reduction way to take random draws from a density function. These draws show to have a self-correcting property over observation. Such a property performs better when the number of random draws for observation is low (about 100), relatively to other simulation techniques. For these and other properties of Halton simulations see Train, K. (2003) *Discrete choice methods with simulation*, Cambridge University Press.

<sup>12</sup> See, for example, Gouriéroux, C. and A. Monfort (1996), *Simulation-Based Econometric Methods*, Oxford University Press.

<sup>13</sup> Schubert, R., Brown M., Gysler M. and H. W. Brachinger (1999) "Financial Decision-Making: Are Women Really More Risk-Averse?" *American Economic Review* 89, 381-385.

specification (5) over the others are correct. Then, more complex models are always rejected in favour of the most parsimonious one, provided that they include unobserved heterogeneity.

<i>Table 1: description of variables included in the analysis</i>	
<b>unobserved heterogeneity</b>	37250 (125 per player) random draws from a standard normal density obtained through a Halton sequence
<b>5<sup>th</sup> round dummy</b>	dummy variable taking the value of 1 if the decision is taken in the 5 <sup>th</sup> round, 0 otherwise
<b>dummy sex</b>	dummy variable taking the value of 1 if the player is a male, 0 otherwise
<b>dummy north</b>	dummy variable taking the value of 1 if the player is from the North of Italy, 0 otherwise
<b>dummy south</b>	dummy variable taking the value of 1 if the player is from the South of Italy, 0 otherwise

<i>Table 2: Probit model - Maximum likelihood results (observations 923) - CARA utility function</i>				
<i>regressor</i>	<i>specification</i>			
	(1)	(2)	(3)	(4)
$\alpha$	0.01087*** (0.00052)	0.00979*** (0.00102)	0.01026*** (0.00056)	0.00903*** (0.00133)
5 <sup>th</sup> round dummy			0.02556*** (0.00575)	0.02488*** (0.00583)
dummy sex		0.00000 (0.00103)		-0.00012 (0.00114)
dummy north		0.00133 (0.00121)		0.00170 (0.00139)
dummy south		0.00172 (0.00128)		0.00203 (0.00139)
$\nu$	0.05870*** (0.00471)	0.05731*** (0.00485)	0.05241*** (0.00496)	0.05205*** (0.00489)
$\tau$	2.90716*** (0.35918)	2.81492*** (0.34222)	2.51363*** (0.27894)	2.51679*** (0.27707)
implied $w$	0.05180	0.05652	0.07491	0.07469
<i>log-likelihood</i>	-310.43394	-310.33925	-301.98999	-300.71002
Standard errors in parentheses				

<i>Table 3: Random effect probit model - Maximum simulated likelihood results (observations 298) - CARA utility function</i>						
<i>regressor</i>	<i>specification</i>					
	(5)	(6)	(7)	(8)	(9)	(10)
$\alpha$	0.01148*** (0.00091)	0.01062*** (0.00273)	0.00654*** (0.00249)	0.01114*** (0.00094)	0.01043*** (0.00145)	0.00651*** (0.00273)
<b>unobserved heterogeneity</b>	0.00882*** (0.00110)	0.00882*** (0.00110)	0.00865*** (0.00104)	0.00917*** (0.00111)	0.00921*** (0.00111)	0.00883*** (0.00095)
<b>5<sup>th</sup> round dummy</b>				0.00928*** (0.00250)	0.00881*** (0.00257)	0.00995*** (0.00251)
<b>dummy sex</b>			0.00419*** (0.00184)		0.00140 (0.00207)	0.00224 (0.00195)
<b>dummy north</b>		0.00099 (0.00300)	0.00305 (0.00247)			0.00422 (0.00282)
<b>dummy south</b>		0.00095 (0.00327)	0.00334 (0.00273)			0.00365 (0.00295)
$\nu$	0.03951*** (0.00622)	0.03936*** (0.00627)	0.03919*** (0.00587)	0.03353*** (0.00667)	0.03392*** (0.00665)	0.03465*** (0.00609)
$\tau$	5.61160*** (2.11558)	5.61161*** (2.05632)	5.61308*** (1.65209)	3.92790 (0.66426)	3.95286*** (0.69890)	3.92746*** (0.64905)
<b>implied <math>w</math></b>	0.00364	0.00364	0.00364	0.01930	0.01884	0.01931
<i>log-likelihood</i>	-94.24548	-94.18431	-93.46472	-93.24639	-92.89554	-92.89554
Standard errors in parentheses						

<i>Table 4: fit of alternative specifications of the model</i>		
<i>Competing specifications</i>	<i>Likelihood ratio test statistic</i>	
<b>1. specification (3) v/s specification (1)</b>	16.8879***	( $\chi_1^2$ )
<b>2. specification (4) v/s specification (1)</b>	19.44784***	( $\chi_4^2$ )
<b>3. specification (4) v/s specification (3)</b>	2.55994	( $\chi_3^2$ )
<b>4. specification (5) v/s specification (1)</b>	432.67392***	( $\chi_1^2$ )
<b>5. specification (6) v/s specification (5)</b>	0.12234	( $\chi_2^2$ )
<b>6. specification (7) v/s specification (5)</b>	1.56152	( $\chi_3^2$ )
<b>7. specification (8) v/s specification (5)</b>	1.99818	( $\chi_1^2$ )
<b>8. specification (9) v/s specification (5)</b>	2.69988	( $\chi_2^2$ )
<b>9. specification (10) v/s specification (5)</b>	2.69988	( $\chi_4^2$ )
<b>10. specification (10) v/s specification (7)</b>	1.13836	( $\chi_1^2$ )
The distribution of the test statistic under the null hypothesis is reported in brackets. '***' null hypothesis rejected at 1% significance level '***' null hypothesis rejected at 5% significance level '*' null hypothesis rejected at 10% significance level		

## 6. Conclusions

The empirical results support our hypothesis that unobserved heterogeneity significantly explains part of people behaviour when confronted with risky choices. The only relevant demographic variable seems to be *dummy sex*.

These encouraging findings suggest that other preference functionals are worth to be investigated on the light of heterogeneity-dependent risk attitude hypotheses.

## References

- Beetma, R. and Shotman, P. (2001), "Measuring risk attitudes in a natural experiment: data from the television game show Lingo", *The Economic Journal*, 111, 821-848
- Friend, I., and Blume M. B. (1975), "The demand for risky assets", *American Economic Review*, 65, 900-922
- Gertner, R. (1993) "Game shows and economic behaviour: risk taking on "Card sharks"", *The Quarterly Journal of Economics*, 108, 507-521
- Gourieroux, C. and A. Monfort (1996), *Simulation-Based Econometric Methods*, Oxford University Press
- Harrison, G. W., and J. List (2004) "Field experiments", *Journal of Economic Literature*, 42, 1009-55
- Loomes G., P.G. Moffatt, and R. Sugden, 2002, "A microeconomic test of alternative stochastic theories of risky choice", *Journal of Risk and Uncertainty*, 24, 103-130
- Metrick, A. (1995), "A natural experiment in "Jeopardy!""", *The American Economic Review*, 85, 240-253
- Peracchi, F. (2001) *Econometrics*, John Wiley & Sons, Chichester.
- Rabin, M. (2000), "Diminishing marginal utility of Wealth cannot explain Risk Aversion", in D. Kahneman - A. Tversky eds., *Choices, Values, and Frames*, Cambridge, Cambridge University Press
- Schubert, R., Brown M., Gysler M. and H. W. Brachinger (1999) "Financial Decision-Making: Are Women Really More Risk-Averse?" *American Economic Review* 89, 381-385
- Stern, S. (2000) "[Simulation Based Inference in Econometrics: Motivation and Methods.](#)" in *Simulation-Based Inference in Econometrics: Methods and Applications*, eds., [Roberto S. Mariano](#), [Melvyn Weeks](#), and [Til Schuermann](#), Cambridge University Press.
- Train, K. (2003) *Discrete choice methods with simulation*, Cambridge University Press