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In this note we describe the S-GG risk-elicitation task. This multiple-lottery allows for obtaining two factors describing a subject's risk attitude with just four choices by this same subject. We describe the implementation of the task and also provide free zTree programs (in English and Spanish) to facilitate its integration into an experimental design. Some frequently asked questions highlighting the advantages and limitations of this task are also provided.

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Abstract

In this note we describe the S-GG risk-elicitation task. This multiple-lottery allows for obtaining two factors describing a subject's risk attitude with just four choices by this same subject. We describe the implementation of the task and also provide free zTree programs (in English and Spanish) to facilitate its integration into an experimental design. Some frequently asked questions highlighting the advantages and limitations of this task are also provided.

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Introduction

In 2002, we published a paper [1], using the basic version of the 'S-GG lottery panel test' in order to elicit subjects' risk attitudes as an external task, parallel to the main experiment on an indefinitely repeated prisoner dilemma game. Over the past 15 years, the test has been often used as a main or a secondary task in risk elicitation studies. An exhaustive list of these studies is beyond the scope of this note, but some of them and the relation of the task to other broadly used risk-elicitation tasks are reviewed and thoroughly discussed in more recent papers [2], [3] and [4]. The purpose of this note is to provide the users of the task with some guidance on the interpretation of the results, especially targeting the less informed user, not interested in the details of the economic theory underlying the functioning of this risk-elicitation task.

The S-GG task

In the basic version of the task, (see the Appendix for layout and implementation instructions, besides access to the z-Tree programs), each panel, offers the decision maker an ordered set of 10 "lotteries" understood as combinations of a probability *p* to win a prize of *X*€ (else nothing). The decision makers have to choose their favorite lottery in each panel. The basic version discussed here has four panels, while a more complete version exists [3], allowing for large stakes and losses. Generally, each panel initially (on the left extreme) offers the possibility of a sure (*p=1*) gain, *X*, which in this version is set to *c=1€*. Beyond that, lotteries on the right of the certain gain, offer a higher gain, at the cost of a lower winning probability and, thus, a higher risk of earning nothing. The increase in the expected value of a lottery as we move to the right towards riskier choices is linear (with the coefficient *t* being increased as we move from panel 1 to 4) in the probability of winning nothing, as indicated by:

(1) $$p \cdot X = c + t \cdot (1 - p)$$

Table: Relative risk aversion coefficients with $U(x) = x^{1-r}/(1-r)$

p	x	r	p	x	r	p	x	r	p	x	r
1	1.00€	0.091	1	1.00€	0.5	1	1.00€	0.833	1	1.00€	0.909
0.9	1.12€	0.082	0.9	1.20€	0.45	0.9	1.67€	0.75	0.9	2.20€	0.818
0.8	1.27€	0.073	0.8	1.50€	0.4	0.8	2.50€	0.667	0.8	3.80€	0.727
0.7	1.47€	0.064	0.7	1.90€	0.35	0.7	3.57€	0.583	0.7	5.70€	0.636
0.6	1.73€	0.055	0.6	2.30€	0.3	0.6	5.00€	0.5	0.6	8.30€	0.545
0.5	2.10€	0.045	0.5	3.00€	0.25	0.5	7.00€	0.417	0.5	12.00€	0.455
0.4	2.65€	0.036	0.4	4.00€	0.2	0.4	10.00€	0.333	0.4	17.50€	0.364
0.3	3.57€	0.027	0.3	5.70€	0.15	0.3	15.00€	0.25	0.3	26.70€	0.273
0.2	5.40€	0.018	0.2	9.00€	0.1	0.2	25.00€	0.167	0.2	45.00€	0.182
0.1	10.90€	0.009	0.1	19.00€	0.05	0.1	55.00€	0.083	0.1	100.00€	0.091
Panel 1			Panel 2			Panel 3			Panel 4		

In this table, we substitute the rule $p \cdot X = c + t \cdot (1 - p)$, with which the lottery panel test is designed [written in the form: $X = (c + t(1 - p))/p$], into the decision maker's problem:

(2) $$max_p \; p \cdot U\left(\frac{c+t(1-p)}{p}\right)$$

where, for the utility *U(·)*, the CRRA form $U(x) = x^{1-r}/(1 - r)$ is adopted. From the expected utility maximization problem, in each panel, an exact $p(r)$ corresponds to each level of *r*, from which, the inverse form is applied to calculate the decision maker's *r*, leading to each chosen *p*, given the alternatives offered in this panel.

Following textbook economic theory, the parameter *r* will be higher the higher the decision-maker's risk aversion. Thus, the more risk averse a subject is, the higher the winning probability of the lottery chosen will be in each panel. This can be seen on the table and has been expressed in an analytical way in [3] and [4]. Or, inversely, in order to map choices into risk attitudes:

Observation 1: *The higher the probability of the lottery chosen by a decision maker, the more risk averse the subject is.*

Therefore, from this observation and the numbers provided in the table, one can accurately map a decision maker's choice onto the parameters of the decision maker's utility and thus, their parameters of risk aversion.

However, before the researcher makes any statement in terms of the links between these decisions, and the basic expected utility theory formulation implied in (2), several warnings are in order:

Observation 2: Discreteness of choice space: *The lotteries provided in the task imply a discrete space of alternatives, whereas the risk aversion parameter, r, is defined over a continuous space. A decision maker's true r will in general be in the interval between the values corresponding to those immediately "before" and "after" the one corresponding to the actual choice in this specific panel.*

Like in other tests, a decision-maker's elicited risk eversion takes exactly one of the values presented in the table, only if the maximum utility coincides with that obtained with the probability of the lottery chosen. However, given the continuity of the decision functional in (2) and its global concavity, this will in general not be the case, but rather a maximum will occur before or after the p chosen, indicating an r in the interval between values specified in the aforementioned observation. Following the same reasoning, the extreme choices corresponding to *p=1* and *p=0.1* may imply an *r* corresponding to higher or a lower, respectively, degrees of risk aversion than the exact one corresponding to the choice in a particular panel. This is summarized in the following observation:

Observation 3: Boundaries of the choice space: *Extreme choices of p=1 and p=0.1 are compatible with all degrees of risk aversion which are higher for the former and lower for the latter than the exact value of r provided for these choices on the table.*

Both observations 2 and 3 are important for the econometric analysis of the elicited risk attitudes as a dependent or independent variable. Specifically, the researcher should apply the appropriate techniques for truncated variables and continuous variables observed in discrete intervals. For consistency and comparability of choices across panels, the use of the probability chosen is far more useful than the corresponding lottery payoff. For reasons that are made clear in the next two observations, it is also not advisable to use the risk aversion parameter values on which "*p* choices" are mapped according to the table.

Observation 4: Parametric inconsistency: *The choice of the same person across panels will rarely, if ever, be compatible with a unique risk aversion parameter.*

Imagine a person whose *r=0*, implying risk neutrality. The person should choose the riskier lottery in all the four panels. This is rarely observed (about 1% of the large sample used in [3]). Also, a person who has chosen *p=0.6* or higher in the fourth panel should not take any risk in panels 1 and 2 (choosing *p=1* in both of them). Generally speaking, the vast majority of choices reported in [2] and [3] are not compatible with a unique utility parameter *r* in $U(x) = \frac{x^{1-r}}{1-r}$. In fact, this utility function has another intuitively appealing but often violated (in about 25% of cases) property. Namely, the pattern of making weakly riskier choices as we move from panel 1 to panel 4. Although the violation of this property is not compatible with the utility function used in this note, it is not a violation of rationality and expected utility as a whole, given that there are conditions concerning the second derivative of $U(x)$ which may lead a subject take less risk as *t* is increased from panel 1 to 4. This possibility is captured in the following observation:

Observation 5: "Monotonicity" of choices across panels: *While the utility function* $U(x) = x^{1-r}/(1-r)$ *and intuition yield the expectation for riskier choices as we move from panel 1 to 4, observed behavior will often (in approximately 25% of the cases) violate this pattern.*

In fact, in [2], subjects violating monotonicity of choices across panels are explained as the result of aspiration to a given reference point of earnings, beyond which no further risk needs to be taken. Such subjects are also shown to be less consistent across different risk elicitation tasks, but from a mathematical point of view their behavior is still compatible with rationality and expected utility maximization, provided that a polynomial of higher degree is chosen to represent the decision maker's utility function.

Following the aforementioned observations, it must be clear at this point that it makes little (if any) sense to reduce the results of the S-GG test into a single utility parameter. All the four choices made in the panels by the subjects could, and probably should, be used to describe their decision making profiles, because it is clear according to the modern theories of risky choice that the term risk aversion cannot be used as synonymous of the much more general term "risk attitude" (for example, rank dependence, probability weighting and loss aversion, to name a few of the generalizations made over the past 50 years, are jointly incompatible with a uni-parametric specification of the functional describing choice under risk).

If, despite the desideratum of a multi-dimensional description of risk attitudes through the four choices in the task, a researcher wishes to obtain a simplified risk profile, based on [3], two factors have been identified as appropriate (and sufficient, explaining 85% of the observed behavior) for a reduced but still multidimensional description of risk attitudes:

Factor 1: *A subject's average p-choice across the four panels*:

$$\bar{p} = \frac{\sum_{i=1}^{4} p_i}{4}$$

Where $i \in \{1, 2, 3, 4\}$ is the number of the panel.

Factor 2: *A subject's p-choice sensitivity to increases in the risk-return parameter t across panels:*

$$\overline{\Delta p} = 0.6(p_1 - p_4) + 0.3(p_2 - p_3)$$

Whose coefficients *0.6* and *0.3* are weights obtained in [3] through principal component analysis of a large dataset. However, these are suggestions which could be improved or further corroborated by principal component analysis if any new data set generated from the implementation of the S-GG task. (Note that both Factor 1 and Factor 2 are automatically computed and stored in the z-Tree programs that we provide in the Appendix).

A measurement instrument should be definitely evaluated and validated on the basis of its usefulness, reliability and performance as a primary or secondary task, but it is often the case that an instrument is used by a researcher because everybody else does. In fact, the selection of the tasks reported as part of an experiment is often conditioned by the existence of positive results, eliminating negative results and leading to a false impression that a task "works" because it is reported when it does.

As a consequence, a number of questions have been collected and are answered below to make it easier for the user to see the advantages and disadvantages of the S-GG risk elicitation task.

Frequently asked questions

FAQ1: *Why some other risk elicitation tasks avoid problems of parametric consistency?*

Answer: In order for a problem of parametric consistency to exist, a task needs to elicit more than one decision of a subject. Even some tasks based on a list of binary choices, in reality, elicit only one decision usually called a "switching point" from the choice on the left to the choice on the right. In fact, such tasks often suffer from multiple switching, which is also difficult to accommodate in a uni-parametric expected utility maximization framework. So, tests that do not suffer from parametric inconsistency are, in general, tests which reduce a subject's risk attitude in a subject's single choice. Researchers must face it sooner or later, that since a long time ago, a subject's risk attitude cannot be described by one number.

FAQ2: *Is it possible that the S-GG task is more demanding than other risk elicitation tasks, in terms of the necessary cognitive resources required when making the four choices?*

Answer: This may be a fair critique to the S-GG task, but may apply *a fortiori* to other similar tasks. Take for example a test based on ten binary choices between pairs of probability-payoff pairs. Ten such choices are made to elicit one point of the subject's behavior towards risk. The S-GG task obtains four such points with four choices among ten probability-payoff pairs. It might be an interesting topic for further research, but this is certainly not an obvious weakness of the S-GG task vis-à-vis other alternatives.

FAQ3: *Are the data generated using the S-GG task comparable, analogous or related at all to data generated by other methods of risk attitude-elicitation?*

Answer: YES! Definitely, the correspondence between *p*-choices and risk aversion parameters provided in the table, make the choices in the S-GG task fully comparable with choices in any other task in which a risk elicitation parameter can be obtained from subjects' choices. See [4], for instance. However, as explained in various occasions above, given the multidimensional nature of the task, it is not straightforward nor desirable to reduce the information obtained through the S-GG task into a single parameter. Furthermore, [2] has established that a statistically significant (although not strong) correlation exists between decisions in this task and other related tasks. The correlation becomes even stronger, provided that the analysis focuses into subjects who act in the intuitively expected way of taking more risk as we move from panel 1 to panel 4. But even this finding requires the multidimensional description of risk attitudes obtained through the S-GG test.

FAQ4: *If the mapping of p-choices on risk aversion parameters is abandoned in favor of simply characterizing risk attitudes through the choices in the four panels, can we say that the resulting elicitation of risk attitudes is "theory-free" and bound to be useful for purely empirical research only?*

Answer: The economic theory on risky decision making is one of the "healthiest" areas of economic research. Theory, in fact, is still under fast evolution which closely follows continuous empirical testing. Like in the case of many psychological measurement domains, for example intelligence, the theory needs to explain thoroughly what happens, but in the meanwhile the need for measurement calls for the development of reliable tools, even in the absence of the perfect theory that explains every single systematic pattern observed. If researchers decide to use a simpler description of a complex phenomenon, they can do so by reducing data from a more complex tool into a more comprehensive set of factors. But this is usually done in the codification, not the elicitation stage, because data from a complex tool can be reduced into few important factors or even a single-dimensional index, while the contrary (augmenting a single-dimensional metric into a multidimensional vector of traits) is impossible. Therefore, if we want to be "closer to the theory", we should map decisions into parameter vectors of higher, not lower dimensions (even less of a single parameter). An example has been provided in [3] of an econometric estimation on S-GG data used to fit a decision model based on Prospect Theory. Needless to say, that data based on single individual decisions in a uni-dimensional task are not appropriate for estimating a similar model.

FAQ5: *How about labs that usually adopt the same risk elicitation task used by everyone to elicit their subjects' risk attitudes?*

Answer: This is often proposed as an advantage of broadly used tasks. And it would be so, if the implementation of a task in different labs by different researchers were made in a uniform way, generating data which can be aggregated into large sets, creating population-wide profiles, including the possibility of "clustering by type" which is particularly useful for comparisons across groups. But this is not the case in economics! Even the most broadly used tasks are applied with several small differences, making the resulting datasets difficult to pool or even compare. Even worse, labs rarely keep data generated by a subject in previous experiments, which leads to two different problems. First, some subjects have performed the same task several times, but the possibility is lost to know whether the risk "preferences" elicited are stable over time, that is, whether they are "preferences" at all, in the standard way economics uses this term. Second, the repetition of some tasks may lead to uncontrolled (dynamic) phenomena, like, for example, habituation, learning, regression to the mean, etc. (See [5] and [6]). How much of all of this preserves the necessary properties to talk about risk elicitation through a single task should be subject to systematic research, but the use of the same task by everybody must not be assumed to imply any advantage, particularly when the important advantage of knowledge and data accumulation and aggregation is mostly missed.

Final thoughts

Risk attitudes are an important subdomain of a decision maker's utility. Both as the main issue under study or as an explanatory variable, they have been extensively studied by theorists and empirical economists. The S-GG task possesses some desirable characteristics for a simple and more complete description of choice under risk.

Appendix

The following figure includes four panels of ten lotteries each.

Panel 1

Prob.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	1.10	1.30	1.50	1.70	2.10	2.70	3.60	5.40	10.90

Panel 2

Prob.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	1.20	1.50	1.90	2.30	3.00	4.00	5.70	9.00	19.00

Panel 3

Prob.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	1.70	5.50	3.60	5.00	7.00	10.00	15.00	25.00	55.00

Panel 4

Prob.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	2.20	3.80	5.70	8.30	12.00	17.50	26.70	45.00	100.00

- In each panel, each column indicates a lottery, that is, a probability "*Prob*" of earning an amount in €; alternatively, nothing. All lotteries have the same structure. The lowest prize per lottery is 1 euro, while the highest prize is 10.90€, 19€, 55€ and 100€ for panels 1, 2, 3 and 4 respectively.
- For each of these panels you have to choose your preferred lottery. That is, you have to submit one decision per panel.
- [FOR EXPERIMENTS WITH REAL REWARDS ONLY] At the end of this task [if it is a parallel task to another experiment: "At the end of the session"] your earnings will be determined following two steps:

  Step 1: A four-sided die will be thrown to determine which panel will be used in step 2.

Step 2: Your choice in the panel determined in step 1 will be implemented. If in that panel you have chosen the p=1 option (1€ for sure), you get 1€. If you have chosen a p<1, then a 10-sided die will be thrown. You will need the highest number (10 or 0, depending on the type of die) to win if you have chosen the lottery with p=0.1; you will need one of two highest numbers if you have chosen a lottery with p=0.2; …. You will need any of the 9 highest numbers (except 1) if you have chosen the lottery with p=0.9 in the panel determined in step 1.

Note for the experimenter: The task could also be fully computerized, in which case, the steps 1 and 2 can be implemented through a random number generating process. However, we normally take volunteers to throw the two physical dice and the results are introduced in the experimenter computer via a Z-Tree screen. This version of the programs, both in Spanish and English, can be freely downloaded using the link below. In addition, if no 4- and 10-sided dice are available, the process of panel determination and lottery resolution can be implemented by small numbered papers in an urn with the equivalent values, tombola numbered balls, etc.

Access to Z-Tree (4.1.11) S-GG Risk Aversion Task ztt files

http://www.lee.uji.es/eng/personales/ivan/SGG_Ztree.ZIP

References:

1. Gerardo Sabater-Grande and Nikolaos Georgantzís, Accounting for Risk Aversion in Repeated Prisoners' Dilemma Games: An Experimental Test, *Journal of Economic Behavior and Organization*, 48(1), 37-50, 2002.
2. Giuseppe Attanasi, Nikolaos Georgantzís, Valentina Rotondi and Daria Vigani, Lottery- and survey-based risk attitudes linked through a multichoice elicitation task. *Theory and Decision*, 84, 341-372, 2018.
3. Aurora García-Gallego, Nikolaos Georgantzís, Ainhoa Jaramillo-Gutiérrez and Melanie Parravano, The lottery-panel task for bi-dimensional parameter-free elicitation of risk attitudes, *Revista Internacional de Sociología,* 70, 53-72, 2012.
4. Iván Barreda-Tarrazona, Ainhoa Jaramillo-Gutiérrez, Daniel Navarro-Martínez and Gerardo Sabater-Grande, Risk attitude elicitation using a multi-lottery choice task: Real vs. hypothetical incentives, *Spanish Journal of Finance and Accounting,* 40, 609-624, 2011.
5. Nikolaos Georgantzís and Daniel Navarro-Martínez, Understanding the WTA-WTP Gap: Attitudes, Feelings, Uncertainty and Personality, *Journal of Economic Psychology*, 31(6), 895-907, 2010.
6. Aurora García-Gallego, Nikolaos Georgantzís, Daniel Navarro-Martínez and Gerardo Sabater-Grande, The Stochastic Component in Choice and Regression to the Mean, *Theory and Decision*, 71, 251-267, 2011.