Retos
Revista de Ciencias de Administración y Economía

April-September 2023
pp.49-59
https://doi.org/10.17163/ret.n25.2023.04

Risk aversion making economic decisions, certainty effect and probabilities estimation

Aversión al riesgo al tomar decisiones económicas, efecto certeza y estimación de probabilidades

Juan Carlos Aguado-Franco
Professor and researcher at Facultad de Ciencias de la Economía y Empresa de la Universidad
juancarlos.aguado@urjc.es
https://orcid.org/0000-0002-8589-911X

Received on: 22/01/2023 **Revised on:** 16/02/2023 **Approved on:** 23/02/2023 **Published on:** 01/04/2023

Abstract: it has been empirically observed that the principles of utility theory are frequently violated when making decisions in risky environments. This led to the formulation of the prospect theory, in which, besides taking into account the different consideration of gains and losses (losses loom larger than gains) as well as the risk posture of decision-makers (risk aversion for gains and risk seeking for losses), the certainty effect is framed. According to such effect, decision makers tend to underestimate payments that are merely probable, compared to those that are obtained with certainty. Allais showed the irrationality that occurs in decision making in this context. On the other hand, to make risky decisions it is necessary to know how probabilities work. An experimental study was designed to determine the relationships between risk aversion, certainty effect, and basic knowledge of probability theory. In this study it was verified, using a formulation based on the Allais paradox, that those who have more knowledge of the principles of probability show greater aversion to risk. However, the fact of incurring in the certainty effect is a circumstance that is not significantly affected by such knowledge.

Keywords: decision theory, rationality, risk aversion, behavioral economics, experiment, Allais paradox, certainly effect, prospect theory.

Resumen: se ha observado empíricamente que la violación de los principios de la teoría de la utilidad se produce con frecuencia en la toma de decisiones en entornos de riesgo. Esto llevó a la formulación de la teoría de las perspectivas en la que, además de tener en cuenta la diferente consideración de las pérdidas y las ganancias, así como la postura ante el riesgo de los decisores, mostrando aversión por el riesgo en las ganancias y amor por el riesgo en las pérdidas, se enmarca el efecto certeza. Según el efecto certeza, los decisores tienen tendencia a infravalorar los pagos que son meramente probables, en comparación con aquellos que se obtienen con certeza. Allais mostró la irracionalidad que se produce en la toma de decisiones en este contexto. Por otro lado, para tomar decisiones arriesgadas, es necesario conocer cómo funcionan las probabilidades. Con el objetivo de determinar las relaciones existentes entre la aversión al riesgo, el efecto certeza y el conocimiento básico de la teoría de las probabilidades, se diseñó un estudio experimental en el que se constató, utilizando una formulación basada en la paradoja de Allais, que quienes tienen mayores conocimientos de los principios de la probabilidad muestran una mayor aversión al riesgo, pero el hecho de incurrir en el efecto certeza, sin embargo, es una circunstancia que no se ve afectada significativamente por dicho conocimiento.

Palabras clave: teoría de la decisión, racionalidad, aversión al riesgo, economía conductual, experimento, paradoja de Allais, efecto certeza, teoría de las perspectivas.

Suggested citation: Aguado-Franco, J. C. (2023). Risk aversion making economic decisions, certainty effect and probabilities estimation. *Retos Revista de Ciencias de la Administración y Economía, 13*(25), 49-59. https://doi.org/10.17163/ret.n25.2023.04

Introduction

The theory of expected utility, developed by Von Neumann and Morgenstern (1944), has been considered through decades as the regulatory model of rational choice in economic decision making in the presence of risk, assuming that the behavior of people would observe its axioms. Thereby, according to this model, the expected utility that an individual would get when facing a lottery would be calculated as the sum of the utilities of the different payments, multiplied by their corresponding probabilities, such that the decision maker would select the alternative with the highest expected utility. However, this statement was questioned since the formulation of the St. Petersburg paradox (Bernouilli, 1738), translated to English here (Bernouilli, 1954), since, among other reasons, it entailed an enormous difficulty to reasonably value those circumstances in which a particular event would offer an extremely high payment that could be obtained with an extremely small probability.

On the other hand, in front of the reiterated evidence found in decision-making processes observed in numerous empirical studies, in which those who have to conduct them systematically violate the principles on which the expected utility theory is based, it is easy to find in the specialized literature different models that have been developed in the attempt to get closer to the reality of the decisions made by individuals (Machina, 1987; Camerer, 1989; Tversky and Kahneman, 1992). The model that has had a greater impact, because it explains the main violations of the expected utility theory in contexts of selection with risk, is the prospect theory model (Kahneman and Tversky, 1979; Tversky and Kahneman, 1986; Tversky and Kahneman, 1992), up to the point that the 1979 paper by both authors is the most-cited one in the field of business and economy (Merigó *et al.*, 2016). Indeed, the aforementioned St. Petersburg paradox has been reconsidered in light of prospect theory (Rieger and Wang, 2006).

Prospect theory

Prospect theory has been well studied and revised (Bendickson *et al.*, 2017), and has been recognized as the descriptive theory of decision making in front of the most relevant risk at present (Barberis, 2013; Starmer, 2000; Wakker, 2010). This theory has been applied in very different fields of decision making (Holmes *et al.*, 2011), such as in the analysis of decisions in real estate markets (Buisson, 2016), bets (Bouchouicha and Vieiden, 2017), insurance (Schmidt, 2016), profitability of shares by dividends (Barberis *et al.*, 2016), decision making related to migrating or remain living at the same place (Morrison and Clark, 2016; Clark and Lisowski, 2017), decisions about betting or not in different periods, in a dynamic context (Ebert and Strack, 2015), decisions about what amount of shares to optimally keep, making reference to the known "newspaper seller problem" (Long and Nasiry, 2015), the effects of bankruptcy laws on corporate aspirations (Estrin *et al.*, 2017), agricultural insurance coverage (Babcock, 2015), aspects related to the volatility and low profitability of investments (Bhootra and Hur, 2015), decisions about carrying out military actions (Niv-Solomon, 2016), international relations between countries (Feng and He, 2017; Stein, 2017), the assumption of risks by politicians (Linde and Vis, 2017), decisions made in the sports sector, concretely in American football (Bendickson *et al.*, 2017), the prediction of sport results (Pérez-Martínez and Rodríguez-Fernández, 2022), and portfolio optimization (Grishina *et al.*, 2017), among others.

In contrast with what occurs in the expected utility theory, in which the aversion or love to risk are solely determined by the profitability function of the individual, several additional factors come into play in prospect theory that affect the decision making process, beyond individual aspects such as the personality of decision-makers (Chávez-Santana *et al.*, 2021; López *et al.*, 2023) and other psychological variables that also have influence on decision making domains, such as game theory (López *et al.*, 2022). Indeed, in prospect theory, the utility function would be concave with respect to the reference point in the case of earnings, while it would be convex with respect to that same point

Print ISSN: 1390-6291; electronic ISSN:1390-8618

in the case of incurring losses. Thus, in the case of earnings as well in the case of losses, the impact of any change will be smaller when we are farther from the initial reference point (there is a decreasing sensitivity in front of the effects of a particular monetary variation experienced).

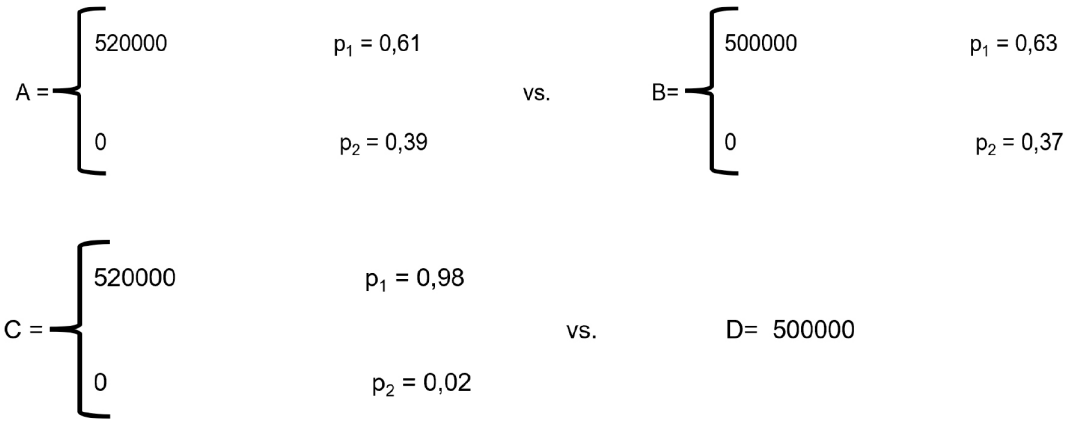
On the other hand, according to this model the slope of the function in the case of losses would be larger than in the case of earnings, thus indicating the existence of an aversion to losses; consequently, an asymmetry is observed as the loss of a particular amount of money has a larger impact on the utility level of the individual than an equivalent earning. At last, the utility is calculated using the monetary earnings or losses experienced, and not the final situation in which the individuals are when these earnings or losses are obtained, as it occurs in the expected utility theory (Tversky and Kahnemann, 1991).

Allais paradox and the certainty effect

The absence of linearity in the preferences that is collected from the statements by Kahneman and Tversky was revealed several decades ago, in the middle of the past century. Indeed, Allais (1953) empirically showed in a scientific congress that the difference between probabilities of 99 % and 100 % have a larger impact on the preferences of the individuals than the difference between, for instance, 10 % and 11 % probability.

In the same line of the conclusions extracted by Maurice Allais, Kahneman and Tversky (1979) stated that decision-makers have a trend to underestimate the payments that are merely probable compared to those that are obtained with certainty; they called this "certainty effect". This trend contributes to the appearance of behaviors that exhibit aversion to risk in cases in which there is the possibility of obtaining a sure payment, while it would cause love for the risk in those other situations in which there are possibilities of sure losses.

The problem that Kahneman (2011) uses to illustrate, in a simplified manner, the dilemmas that enable to explain Allais paradox could be represented as follows:



For these two situations represented, in which either alternative A or alternative B should be chosen in the first occasion, and C or D in the second, most people chose the 520,000 lottery in the first dilemma (earn 520,000 with a probability of 0.61 compared to earning 500,000 with a probability of 0.63), while they choose alternative D in the dilemma of the lower part (choosing to earn 500,000 with certainty instead of earning 520,000 with a probability of 0.98). In this manner, the utility theory is being violated, since the probability increase of 0.37 in the alternatives of the lower part with respect to the upper part would favor alternative C more than alternative D, because it increases the possibility of obtaining 520,000 in the first case, and of obtaining 500,000 in the second case. Therefore, a "certainty effect" occurs, according to which the results that are obtained almost with certainty are assigned a lower value than the one that would be justified by its probability.

Using the criterion of maximizing the expected monetary value, it is calculated and compared for each alternative:

$$VEM(A) = 520000 \times 0{,}61 + 0 \times 0{,}39 = 317200$$
$$VEM(B) = 500000 \times 0{,}63 + 0 \times 0{,}37 = 315000$$
$$VEM(C) = 520000 \times 0{,}98 + 0 \times 0{,}02 = 509600$$
$$VEM(D) = 500000$$

Therefore, $EMV(A) > EMV(B)$ and $EMV(C) > EMV(D)$

The decision maker should, in this case, choose alternative A and alternative C instead of B and D, respectively. Nevertheless, there is no interest in comparing the expected earnings of the different alternatives, but the utility that the individual receives from such earnings.

Indeed, according to the Von Neuman-Morgenstern utility functions, if it is assumed that an individual prefers the first alternative instead of the second in the first decision problem, it is obtained that:

$$0{,}61 \times u(520) > 0{,}63 \times u(500)$$

On the other hand, in the case of a monotonically increasing utility function, it is evident that:

$$0{,}37 \times u(520) \geq 0{,}37 \times u(500)$$

Adding the two sides of the previous inequalities, it should hold that:

$$0{,}98 \times u(520) > 1 \times u(500)$$

Therefore, if a decision-maker chooses A instead of B, he/she should choose C instead of D.

In other words, alternative C should be chosen instead of alternative D, regardless if the decision-maker shows aversion or love for risk. Someone that chooses alternatives A and D would be violating the principles of expected utility; there is no utility function compatible with both decisions. Therefore, this would be an irrational decision. Indeed, Daniel Kahneman acknowledges that one of the first objectives proposed when he started to work with Amos Tversky, was to find an appropriate psychological explanation of why Allais paradox is produced (Kahneman, 2011) and why, to this day, different versions of the Allais paradox are still used to study and analyze decision making of individuals in risk situations (Berlinger, 2015; Bruhin *et al.*, 2022).

As stated by Thaler (2016), people choose among different alternatives based on a set of expectations about the consequences of their decisions, as well as on different exogenous factors that may determine how all these variables will evolve in the future. In addition, economists traditionally assumed that such beliefs were free of biases and, at present, this idea is not generally shared; this can be seen in the existing literature, part of which has been referenced in the previous subsection.

Indeed, as pointed out by Slovic and Tversky (1974), in front of the observation and empirical confirmation of the violation of the axioms of rational decision theory, many decision theorists considered that those events should be treated as judgement errors due to oversights, absence of appropriate incentives, or simply errors in the understanding of the problems stated. However, the existence of numerous heuristics and cognitive biases in the behavior of individuals when making economic decisions in risk or uncertain environments has been profusely studied, as well as the contributions from economic psychology or behavioral economics, analyzing the existence of framing effect, provision effect, anchoring effect, possibility effect, certainty effect, etc., that have come to enrich knowledge about how such decision making process occurs and what factors affect such behavior.

On the other hand, there are very recent empirical studies which demonstrate that the preferences of individuals are not given in an immovable manner, but they are constructed on the go influenced by the context of decision making, and their recent experience in such context (Kusev *et al.*, 2020, 2022). Delving deeper in this line, this study will introduce a consideration that has not been generally contemplated in the

Print ISSN: 1390-6291; electronic ISSN:1390-8618

existing literature, which consists in finding the relationship that may exist between the level of understanding that the individuals have about the probability of occurrence of a particular event, with the stance that these individuals have in front of risk in situations favorable for the appearance of the certainty effect.

Indeed, basic mathematical knowledge about probabilities, which is often assumed in the aforementioned studies, seems to be relevant when someone faces a decision problem in which different results may be obtained based on particular events that may occur with a specific probability, such that the lack of knowledge of these basic principles of probability might somehow influence their decisions. Thus, even being aware that there are many different variables that influence decision making of individuals, the objective is to better understand the reasons that lead to different attitudes towards the risk, incorporating this new variable, i.e., the basic knowledge or lack of knowledge of the probability of occurrence of a particular event.

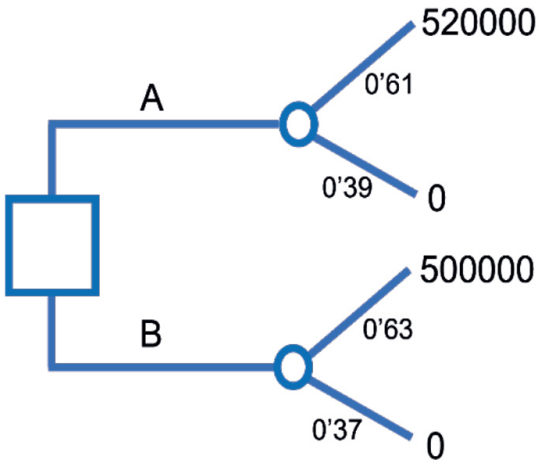
Methodology

In the context of the XXVI Jornada Internacional de Investigación de la Universidad Pedagógica y Tecnológica de Colombia, an experimental study was conducted in which a decision problem was posed to the audience, as was done by Maurice Allis in Paris during a meeting to discuss about risk economy attended by economists such as Samuelson, Arrow, Friedman or the statistician Jimmie Savage. The problem was posed both to those who attended in-person and those who followed it remotely through virtual media, to minimize the possible bias that might appear as a result of the communication between participants when responding the questions. It was obtained 149 responses to the designed questionnaire, in which no information was requested that would enable to identify the respondents, so that they could respond freely and with absolute confidentiality.

After seeing the graphical representation of the problem shown in figure 1 in the questionnaire that they filled out, respondents had to choose between alternatives A and B based on their preferences. These alternatives would enable them to hypothetically obtain payments according to the following statement:

> *Imagine that you face a game as the one shown in the image. If you choose alternative A, you will earn 520,000 with a probability of 0.61 and will earn nothing with a probability of 0.39. Conversely, if you choose alternative B, you will earn 500,000 with a probability of 0.63 and will earn nothing with a probability of 0.37. Indicate below which alternative would you choose.*

Figure 1
First problem of selection between two alternatives

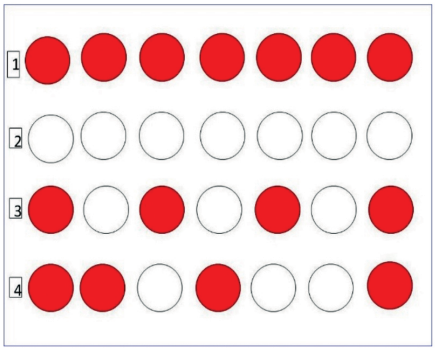


With the purpose of knowing the degree of understanding that the participants in the study had about the probabilities of random events, the following problem was posed:

> *Imagine that a ball is randomly drawn from a bag that contains 50 red balls and 50 white balls. The color of the ball drawn is registered, the ball is placed back in the bag, and the process is repeated up to 7 times. Indicate which of the following sequences you consider that is most probable to occur.*

The sequences to which the statement makes reference are shown in figure 2.

Figure 2
Red and white balls



The possible responses presented in the questionnaire, according to the sequences shown in the image, were the following:

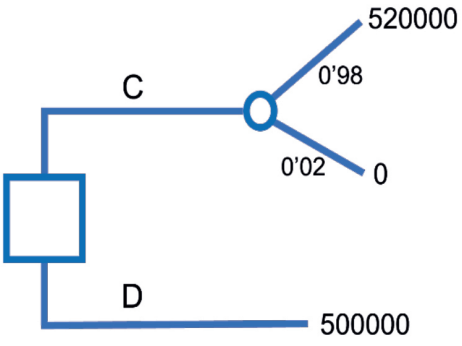
- red, red, red, red, red, red, red
- white, white, white, white, white, white, white
- red, white, red, white, red, white, red
- red, red, white, red, white, white, red
- all the above sequences have the same probability

The correct response is the last one, since all sequences have the same probability (1/128).

Afterwards, the participants in the study had to respond what alternative they would choose when the probabilities of obtaining the payments of the initial decision problem were modified, according to the problem represented in figure 3, which corresponded to the following statement:

> *Imagine that you face a game as the one shown in the image. If you choose alternative A, you will earn 520,000 with a probability of 0.98 and will earn nothing with a probability of 0.02. Conversely, if you choose alternative B, you will earn 500,000 with certainty. Indicate below which alternative would you choose.*

Figure 3
Second problem of selection bet



Print ISSN: 1390-6291; electronic ISSN:1390-8618

When considering the responses given to both decision problems, the situation examined corresponds to the statement of "Allais paradox", and attempts to show the inconsistency exhibited by some individuals in decision making, which leads them to violate the expected utility theory.

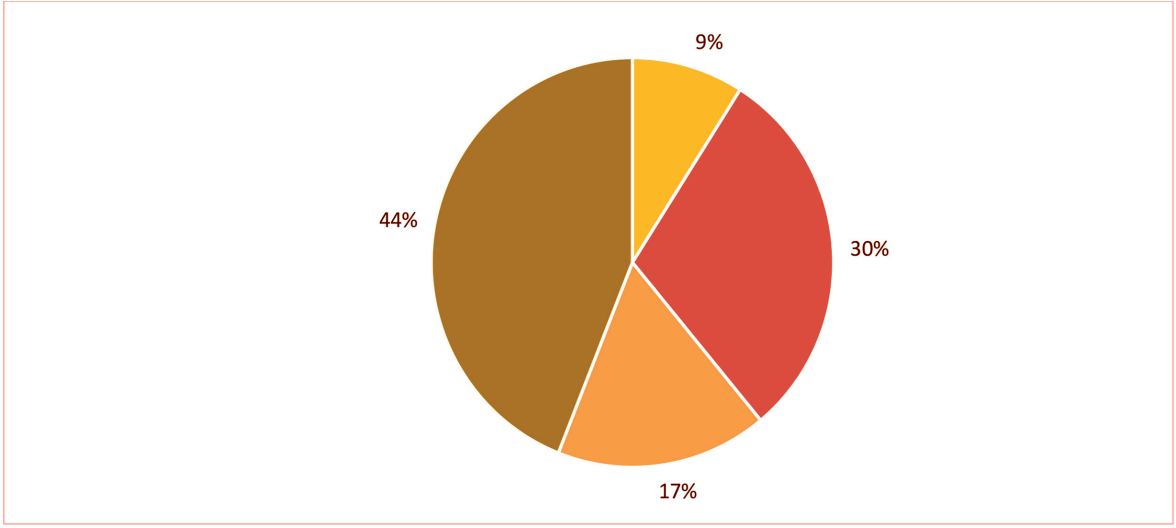
Indeed, a person who chooses alternative A in the first problem "should" also choose it in the second. This is the case because, in the second problem, the probability of obtaining a payment of 520,000 in alternative A has increased 37 % with respect to the initial problem, while in alternative B the probability of obtaining a payment of 500,000 has also increased 37 %.

Therefore, the expected earning of alternative A has increased 192,400, while the expected earning of alternative B has only increased 185,000; if alternative A is chosen in the first problem, with more reason it should be chosen in the second problem based on "economic rationality".

Results

The 30 % of the participants in the study (see figure 4) incurred in the situation of underestimating the results that are merely probable compared with the results that are obtained with certainty, responding A and D in the two decision problems stated.

Figure 4
Response to the decision problems



The other three possible combinations of responses that were obtained are the following:

- AC (9 %) correspond to people attracted by the possibility of obtaining the highest payment of 520,000, and are consistent in their selections in the sense that they choose A in the first problem and also in the second.
- BC (17 %) correspond to people that show aversion to risk in the first statement because they choose the alternative with the smaller expected earning, but in which the probability of earning nothing is lower. However, these people are attracted by the probability very close to 1 of obtaining the highest payment (520,000) in the second problem. It could be interpreted that initially both alternatives were very close to each other in the rating of the individual, with a slight advantage for alternative B, but the improvement experienced in the payment when going from alternative A to alternative C, which is greater than the one experienced when going from B to D, has imbalanced the scale in favor of the first alternative.

- BD (44 %) are people that show aversion to risk in both problems, choosing always the alternative with the higher probability of obtaining a payment.

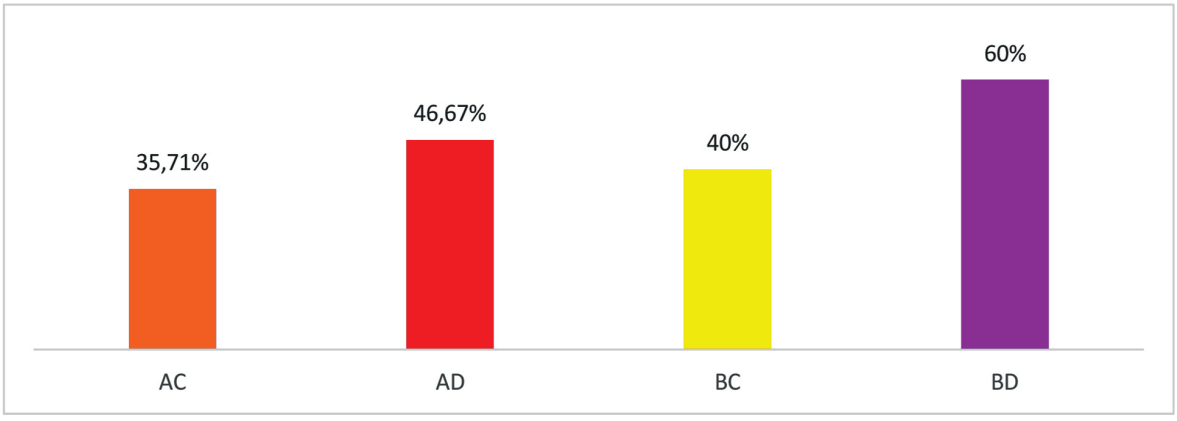
Regarding the question that pursued to know to what extent the participants in the study had a basic knowledge of probabilities, only 50.34 % of the responses issued were correct, with the failures being distributed almost evenly among those who thought that the most likely sequence was alternating colors (red, white, red, white, red, etc.) and those who considered that the most likely sequence is "red, red, white, red, white, white, red". It is not hard to explain that the responses of a rather high percentage of people were both erroneous.

In the first case, since the color of each ball drawn may be red or white with equal probability, people may think that after drawing a ball of a particular color, red for instance, the following ball drawn "should be" white, and hence the subsequent should be red and then white and so forth, without realizing that the events are independent and that the experiment corresponds to a drawing with replacement; hence, at each stage the probability of each color is equal to 0.5. On the other hand, in the second case the sequence does not follow any concrete pattern that may be easily recognized, and thus people may assume that it has a higher probability of occurrence than the others in which a clear sorting can be indeed observed. That is an error, because such specific sequence has the same probability of occurrence than, for instance, all balls drawn of the same color or alternating colors.

Now, the following analysis question arises given these data: is there any relationship between the people that responded correctly (or erroneously) to the question of red and white balls, and the responses given in the Allais paradox problem? To carry out this analysis, a graph has been made that shows the percentage of people that responded correctly to the question of red and white balls, relating it with the responses given in the Allais paradox problem. Thus, before relating these results with the ones obtained in the decision problem, a significant difference of correct responses is already seen in favor of those who responded BD, with 60 %, which is much greater than those who responded AC (35.71 %) and BC (40 %).

Figure 5

Percentage of correct responses to the question of probability estimation according to the groups of the Allais experiment



Conclusions and discussion

Over the course of history, it has been studied how individuals make economic decisions when they face the problem of choosing among different alternatives, in which the results that they may obtain depend on different circumstances, which can have associated a probability of occurrence. The criterion of maximization of the monetary

Print ISSN: 1390-6291; electronic ISSN:1390-8618

expected value, which consists in choosing the alternative that has the greatest expected earnings after performing a weighted sum of the different payments multiplied by their corresponding probabilities, was surpassed when it was considered the stance in front of the risk using the utility functions (Von Neuman-Morgenstern, 1944).

However, many situations kept arising in which decision-makers systematically violated the utility theory principles. Thus, there is a wide consensus to admit that the fact of varying the way in which problems are presented (for example, in terms of earnings or losses), systematically leads to the expression of different preferences; this has been called the "framing effect". Similarly, although in the economic analysis of decisions in risk and uncertain environments it is generally assumed the existence of risk aversion, there are circumstances in which decision-makers show love for the risk. For instance, this occurs when buying lottery. In the lottery, there is negligible probability of obtaining a very high prize, but if the monetary expected value of the lottery is calculated, by adding all possible payments multiplied by the probability of obtaining each of them (including the possibility of earning nothing), it is obviously obtained a result that is substantially lower than the price paid. It was also observed love for the risk, when there is an obligation to choose between incurring in a sure loss and obtaining a loss even greater, not certain, but that can occur with a high probability. The possibility of being able to avoid such loss, even with a very low probability, may result attractive if it is compared with the alternative of having a loss with certainty.

As it was demonstrated by Allais (1953) and has been explained in this paper, the existence of nonlinear preferences is another of the circumstances in which inconsistencies appear in the behavior of individuals in the process of making economic decisions, leading them to act in a way that can be described as "irrational" according to the postulates of utility theory. The existence of the certainty effect, which was suggested by Allais and which is explained in the prospect theory developed by Kahneman and Tversky (1992), is behind this irrationality.

As has been mentioned above, the probability of occurrence of the different events is a fundamental factor for decision making. Thus, it is assumed that the results that may be obtained as a consequence of the decisions made among different alternatives, will be conditioned by such probabilities. This involves some knowledge about probabilities, not the ones that affect the problem addressed, but the concept of probability in general. Otherwise, the aforementioned irrationalities would have an additional source based on the lack of knowledge or on the confusion.

Analyzing the data provided in the results section, it could be observed that the group of people that made selections in which they showed to be affected by the certainty effect in a clearer manner, i.e., those who responded alternative A and alternative D successively for the two decision problems that were stated, have a percentage of success in the question regarding probability (the one of the red and white balls) that is very close to the mean: 46.67 compared to 49.66. Therefore, based on the data of this study it is not possible to conclude that there is a relationship between the two events. Nevertheless, it should be remarked the percentage of people (60 %) that selected alternatives B and D in the Allais paradox problems (choosing those lotteries in which they had a larger probability of winning, even when the payment was smaller than the one offered by the other alternative, thus showing aversion to risk) and who simultaneously responded correctly to the question related to probabilities estimation (indicating that all sequences presented had the same probability of occurrence). Indeed, this percentage is 50 % greater than the corresponding to those who responded B and C to the two questions, and almost 70 % greater of those who chose alternative A in the first question and C in the second.

In the absence of more studies that verify the results with larger samples and considering additional factors, from the data of this work it may be concluded that there is a positive relationship between the appropriate understanding of the probabilities of occurrence of particular events with the fact of showing a greater level of risk aversion. Conversely, as the knowledge about

how probabilities work is smaller, it is more likely that individuals make risky decisions in which they may obtain losses that are rather high. In any context of decision making (public administration, corporate or particular private administration), it is necessary to understand which are the factors that affect people when they face situations of decision under risk or uncertainty, since results will partially depend on them. This study points out the convenience of reinforcing the mathematical study of probabilities, so that individuals are capable of making economic decisions (for instance, investment decisions) that are not penalized by the possibility of incurring in high risks as a consequence of a limited knowledge of probability theory.

References

Allais, M. (1953). Le Comportement de l'Homme Rationnel devant le Risque: Critique des Postulats et Axiomes de l'Ecole Americaine. *Econometrica: journal of the Econometric Society, 21*(4), 503-546. https://doi.org/10.2307/1907921

Babcock, B. A. (2015). Using cumulative prospect theory to explain anomalous crop insurance coverage choice. *American Journal of Agricultural Economics, 97*(5), 1371-1384. https://doi.org/10.1093/ajae/aav032

Barberis, N. C. (2013). Thirty years of Prospect Theory in economics: A review and assessment. *The Journal of Economic Perspectives: A Journal of the American Economic Association, 27*(1), 173-196. https://doi.org/10.1257/jep.27.1.173

Barberis, N., Mukherjee, A. and Wang, B. (2016). Prospect theory and stock returns: An empirical test. *The review of financial studies, 29*(11), 3068-3107. https://doi.org/10.1093/rfs/hhw049

Bendickson, J., Solomon, S. J. and Fang, X. (2017). Prospect theory: The impact of relative distances. *Journal of Managerial Issues, 29*(2), 155-168. http://bit.ly/3ktEo2x

Berlinger, E. (2015). Risk appetite. *Pénzügyi Szemle/ Public Finance Quarterly-Journal of Public Finance, 60*(1), 49-62.

Bernoulli, D. (1738). Specimen theoriae novae de mensura sortis. *Commentarii Academiae Scientiarum Imperalis Petropolitanae, 5*, 175-192.

Bernoulli, D. (1954). Exposition of a new theory on the measurement of risk. *Econometrica: Journal of the Econometric Society, 22*(1), 23. https://doi.org/10.2307/1909829

Bhootra, A. and Hur, J. (2015). High idiosyncratic volatility and low returns: A prospect theory explanation. *Financial Management, 44*(2), 295-322. https://doi.org/10.1111/fima.12057

Bruhin, A., Manai, M. and Santos-Pinto, L. (2022). Risk and rationality: The relative importance of probability weighting and choice set dependence. *Journal of Risk and Uncertainty, 65*(2), 139-184. https://doi.org/10.1007/s11166-022-09392-x

Buisson, F. (2016). Prospect theory and loss aversion in the housing market. *The Journal of Real Estate Research, 38*(2), 229-250. https://doi.org/10.1080/10835547.2016.12091444

Camerer, C. F. (1989). An experimental test of several generalized utility theories. *Journal of Risk and Uncertainty, 2*(1), 61-104. https://doi.org/10.1007/bf00055711

Chávez-Santana, L., Ruiz-Mafé, C. and Curras-Pérez, R. (2021). Efectos de los usos y gratificaciones de Facebook en la elección de destinos turísticos. *Revista de Ciencias Sociales, 3*, 120-138. https://doi.org/10.31876/rcs.v27i3.36760

Clark, W. A. V. and Lisowski, W. (2017). Prospect theory and the decision to move or stay. *Proceedings of the National Academy of Sciences of the United States of America, 114*(36), E7432-E7440. https://doi.org/10.1073/pnas.1708505114

Ebert, S. and Strack, P. (2015). Until the Bitter End: On prospect theory in a dynamic context. *American Economic Review, 105*(4), 1618-1633. https://doi.org/10.1257/aer.20130896

Estrin, S., Mickiewicz, T. and Rebmann, A. (2017). Prospect theory and the effects of bankruptcy laws on entrepreneurial aspirations. *Small Business Economics, 48*(4), 977-997. https://doi.org/10.1007/s11187-016-9810-1

Feng, H. and He, K. (2017). China's institutional challenges to the international order. *Strategic Studies Quarterly, 11*(4), 23-49. http://www.jstor.org/stable/26271633

Grishina, N., Lucas, C. A. and Date, P. (2017). Prospect theory–based portfolio optimization: an empirical study and analysis using intelligent algorithms. *Quantitative Finance, 17*(3), 353-367. https://doi.org/10.1080/14697688.2016.1149611

Holmes, R. M., Jr, Bromiley, P., Devers, C. E., Holcomb, T. R. and McGuire, J. B. (2011). Management theory applications of prospect theory: Accomplishments, challenges, and opportunities. *Journal of Management, 37*(4), 1069-1107. https://doi.org/10.1177/0149206310394863

Print ISSN: 1390-6291; electronic ISSN:1390-8618

Kahneman, D. (2011). *Thinking, fast and slow*. Penguin Books.

Kahneman, D., Slovic, P. and Tversky, A. (eds.) (1982). *Judgment under uncertainty: Heuristics and biases*. Cambridge University Press.

Kahneman, D. and Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society, 47*(2), 263. https://doi.org/10.2307/1914185

Kusev, P., van Schaik, P., Martin, R., Hall, L. and Johansson, P. (2020). Preference reversals during risk elicitation. *Journal of Experimental Psychology General, 149*(3), 585-589. https://doi.org/10.1037/xge0000655

Kusev, P., van Schaik, P., Teal, J., Martin, R., Hall, L. and Johansson, P. (2022). How false feedback influences decision-makers' risk preferences. *Journal of Behavioral Decision Making, 35*(5). https://doi.org/10.1002/bdm.2278

Linde, J. and Vis, B. (2017). Do politicians take risks like the rest of us? An experimental test of prospect theory under MPs. *Political Psychology, 38*(1), 101-117. https://doi.org/10.1111/pops.12335

Long, X. and Nasiry, J. (2015). Prospect theory explains newsvendor behavior: The role of reference points. *Management Science, 61*(12), 3009-3012. https://doi.org/10.1287/mnsc.2014.2050

López, R., Calvo, J. L. and De la Torre, I. (2022). Teoría de juegos conductual y psicológica: una revisión sistemática. *Retos Revista de Ciencias de la Administración y Economía, 12*(24), 308-328. https://doi.org/10.17163/ret.n24.2022.07

López, R., Calvo, J. L. and De la Torre, I. (2023). Relación entre personalidad y toma de decisiones en los juegos económicos. *Revista Venezolana de Gerencia, 28*(101), 11-28. https://doi.org/10.52080/rvgluz.28.101.2

Machina, M. J. (1987). Choice under uncertainty: Problems solved and unsolved. *The Journal of Economic Perspectives: A Journal of the American Economic Association, 1*(1), 121-154. https://doi.org/10.1257/jep.1.1.121

Merigó, J. M., Rocafort, A. and Aznar-Alarcón, J. P. (2016). Bibliometric overview of business & economics research. *Journal of Business Economics and Management, 17*(3), 397-413. https://doi.org/10.3846/16111699.2013.807868

Morrison, P. and Clark, W. A. V. (2016). Loss aversion and duration of residence. *Demographic Research, 35*, 1079-1100. https://doi.org/10.4054/demres.2016.35.36

Niv-Solomon, A. (2016). When risky decisions are not surprising: An application of prospect theory to the Israeli war decision in 2006. *Cooperation and Conflict, 51*(4), 484-503. https://doi.org/10.1177/0010836716640837

Pérez-Martínez, A. and Rodríguez-Fernández, A. (2022). Economía conductual: su influencia en la predicción de resultados deportivos. *Retos Revista de Ciencias de la Administración y Economía, 12*(23), 125-138. https://doi.org/10.17163/ret.n23.2022.08

Rieger, M. O. and Wang, M. (2006). Cumulative prospect theory and the St. Petersburg paradox. *Economic Theory, 28*(3), 665-679. https://doi.org/10.1007/s00199-005-0641-6

Schmidt, U. (2016). Insurance demand under prospect theory: A graphical analysis. *The Journal of Risk and Insurance, 83*(1), 77-89. http://www.jstor.org/stable/43998253

Slovic, P. and Tversky, A. (1974). Who accepts Savage's axiom? *Behavioral Science, 19*(6), 368-373. https://doi.org/10.1002/bs.3830190603

Starmer, C. (2000). Developments in non-expected utility theory: The hunt for a descriptive theory of choice under risk. *Journal of Economic Literature, 38*(2), 332-382. https://doi.org/10.1257/jel.38.2.332

Stein, J. G. (2017). The micro-foundations of international relations theory: Psychology and behavioral economics. *International Organization, 71*(S1), S249-S263. https://doi.org/10.1017/s0020818316000436

Tversky, A. and Kahneman, D. (1986). Rational choice and the framing of decisions. *The Journal of Business, 59*(S4), S251. https://doi.org/10.1086/296365

Tversky, A. and Kahneman, D. (1991). Loss aversion in riskless choice: A reference dependent model. *Quarterly Journal of Economics, 107*(4). https://bit.ly/3md3QK1

Tversky, A. and Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5*(4), 297-323. https://doi.org/10.1007/bf00122574

Von Neumann, J. and Morgenstern, O. (1944). *Theory of games and economic behavior.* Princeton University Press.

Wakker, P. P. (2010). *Prospect theory for risk and ambiguity.* Cambridge University Press.