Economics Letters 244 (2024) 112034

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

# Does the Allais paradox survive with non-monetary consequences?

Danae Arroyos-Calvera [a,*], Andrea Isoni [b], Graham Loomes [b], Rebecca McDonald [a]

[a] University of Birmingham, United Kingdom
[b] Warwick Business School, United Kingdom

ARTICLE INFO

*JEL codes:*
C91
D81
D91

*Keywords:*
Common ratio effect
Allais paradox
Consumer goods
Risk attitudes

ABSTRACT

The form of the Allais paradox known as the common ratio effect (CRE) is a violation of deterministic expected utility theory that has been widely replicated with monetary outcomes. Its robustness has stimulated the development of numerous alternative models of risky choice. However, much less is known about the prevalence of the CRE in decisions involving non-monetary outcomes. We conduct a controlled laboratory comparison of the CRE for money versus consumer goods. The CRE is very strong with money, but largely disappears for goods, primarily as a result of differences in risk attitudes between goods and money. We caution against assuming that findings from experiments involving monetary lotteries will reliably generalise to other types of consequences.

## 1. Introduction

In most experimental research in decision theory, the objects of choice are lotteries with monetary consequences. Many theories assume that consequences of all kinds can be mapped onto some index of subjective value, implying that behaviour involving monetary consequences generalises to the world at large. We test the validity of this assumption using the *common ratio effect* (CRE; Allais, 1953; Kahneman and Tversky, 1979), a highly robust behavioural pattern incompatible with deterministic Expected Utility Theory (EUT). Does the CRE survive when the outcomes are non-monetary consumer goods? If not, we must question the generality of results obtained using monetary outcomes in experimental tests.

A typical format for the CRE involves two pairs comprising a comparatively safe (S) and a comparatively risky (R) prospect, with consequences $h$, $l$ and 0 such that $u(h) > u(l) > u(0) = 0$, and a constant ratio of the probabilities of the non-zero outcomes across the prospect pairs.

$$\text{`}Scaled-up\text{'}\ pair: \ S_u = (l, 1)\ vs.\ R_u = (h, 0.8)$$

$$\text{`}Scaled-down\text{'}\ pair: \ S_d = (l, 0.25)\ vs.\ R_d = (h, 0.2)$$

According to EUT, someone who chooses $R_u$ ($S_u$) over $S_u$ ($R_u$) should also choose $R_d$ ($S_d$) over $S_d$ ($R_d$). However, in numerous studies (see the meta-review by Blavatskyy et al., 2023) many people choose $S_u$ over $R_u$ but choose $R_d$ over $S_d$. The opposite violation – choosing $R_u$ and $S_d$ – is relatively rare. This asymmetry is the CRE.

Some early CRE evidence suggested that the effect might extend to cases involving non-monetary consequences. Kahneman and Tversky (1979) found the CRE with questions that involved (hypothetical) vacation options. Keller (1985) found it when the (hypothetical) consequences were Porsche and Volkswagen cars. To investigate this issue more rigorously, we report an incentivised experiment that compares monetary and non-monetary outcomes of equal value.

## 2. Experimental design

We posed five sets of questions. Each set involved a choice between a scaled-up pair $S_u$ and $R_u$, and a choice between a scaled-down pair $S_d$ and $R_d$ with probabilities as defined above.

The *Baseline* sets used $l = £30$ and $h = £40$, seeking to replicate the standard CRE. In the *Related Objects* set, $l$ and $h$ were two alarm clocks with different features, and in the *Related Money Equivalents* set, those two clocks were replaced by the respondent's money values for them, elicited by the procedure described shortly. In the *Unrelated Objects* set, $l$ and $h$ were two objects chosen from a broader set of harder-to-compare

* Corresponding author at: University House, 116 Edgbaston Park Road, B15 2TT.
*E-mail address:* D.ArroyosCalvera@bham.ac.uk (D. Arroyos-Calvera).

https://doi.org/10.1016/j.econlet.2024.112034
Received 31 July 2024; Received in revised form 17 October 2024; Accepted 17 October 2024
Available online 21 October 2024

goods (e.g. a toaster and an airbed). In the *Unrelated Money Equivalents* set, each object was replaced by the participant's money equivalent for it. The resulting ten choices were scattered amongst other unrelated choice pairs. All pairs were presented as in Fig. 1.[1] This design aims to make controlled comparisons across different consequences of identical subjective value. Under such conditions, if the CRE is observed for money but not for goods, the difference must be due to the nature of the consequences.

To establish accurate money equivalences, our fully-incentivised procedure had several components. First, participants were encouraged to physically inspect the objects; they also read about their characteristics on their screen and printed cards, and answered questions about whether they already owned them and how much they would like to receive them. Participants then made choices between all possible pairwise combinations of the ten objects and three amounts of money (£5.25, £8.75, £19.50), which encouraged them to make comparisons between money and goods. Based on these choices, an algorithm constructed a personalised provisional ranking of the ten objects and the three money amounts. Participants were invited to adjust the ranking to best represent their preferences. Once the ranking was confirmed, participants assigned a money equivalent to each item by dragging and dropping its picture onto a scale that started at £0 and increased in £0.25 intervals with no endpoint. Participants did not know that these money equivalents would feature in subsequent choices. (See Appendix A for details.)

The elicited monetary values guided our selection of goods for each participant in the Related and Unrelated Objects sets. To maximise comparability, we selected pairs of items with a personal value ratio as close as possible to 4:3, which is the ratio of money payoffs in the Baseline set. However, what is important is not the 4:3 ratio, but the equivalence of the value of the goods and money.

## 3. Results

We analyse responses from 60 University of Warwick students (67% female, mean age 21.75).[2] Each participant received a show-up fee of £3 plus a reward dependent on their choice in a single randomly selected question.

For each question set, Fig. 2 reports the frequencies of the four possible choice combinations: $S_u\&S_d$ and $R_u\&R_d$ (which are both consistent with EUT), $S_u\&R_d$ (the prevalent CRE inconsistency) and $R_u\&S_d$ (the reverse inconsistency).

Our Baseline question replicates the usual CRE pattern: the $S_u\&R_d$ inconsistency is much more frequent ($n = 23$) than the opposite $R_u\&S_d$, ($n = 5$) (compare the dashed sections of the first bar). The other sets reveal two clear patterns. First, the CRE is always strong with monetary consequences, even though they may not have value ratios of precisely 4:3. For Related Money Equivalents, the ratio between $S_u\&R_d$ and $R_u\&S_d$ is 19:2, and for Unrelated Money Equivalents it is 30:4. Second, this asymmetry is much less pronounced for non-monetary consequences: 14:6 and 9:4 for the Related Objects and Unrelated Objects respectively.

The difference between money and objects is largely due to the different patterns of responses to the scaled-up questions, which suggest more risk aversion for money than for objects. For both Related ($\chi^2 p = 0.0016$) and Unrelated Objects ($p = 0.0133$), the $S_u$:$R_u$ ratios are significantly different from those in their Money Equivalent counterparts (compare the grey and white sections of the relevant bars). With money, a clear majority favour the safer lottery; whereas with goods, the

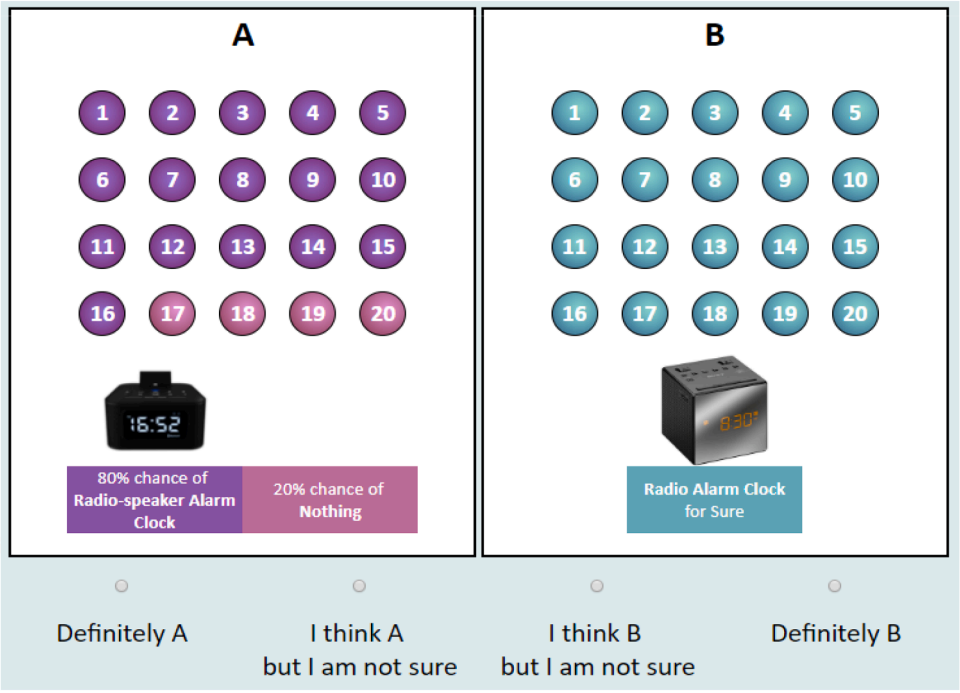


**Fig. 1.** Example of a scaled-up CRE question in the Related Objects set.
Note: Participants chose between prospect A (left) and prospect B (right), indicating their degree of confidence. Whether A was the safer or riskier prospect was randomised.

[1] For consistency with the response scale used in other questions in the larger study in which the CRE questions were embedded, participants also indicated their degree of confidence in their choices. For present purposes, we only consider which option was chosen. Further information about the degree of confidence data is in Appendix B.

[2] Since the cost of some of the objects was substantial, this limited the size of the sample. Data available at: https://osf.io/nwq5c/files/osfstorage/66aa4227af3f209c9aa1b50e.

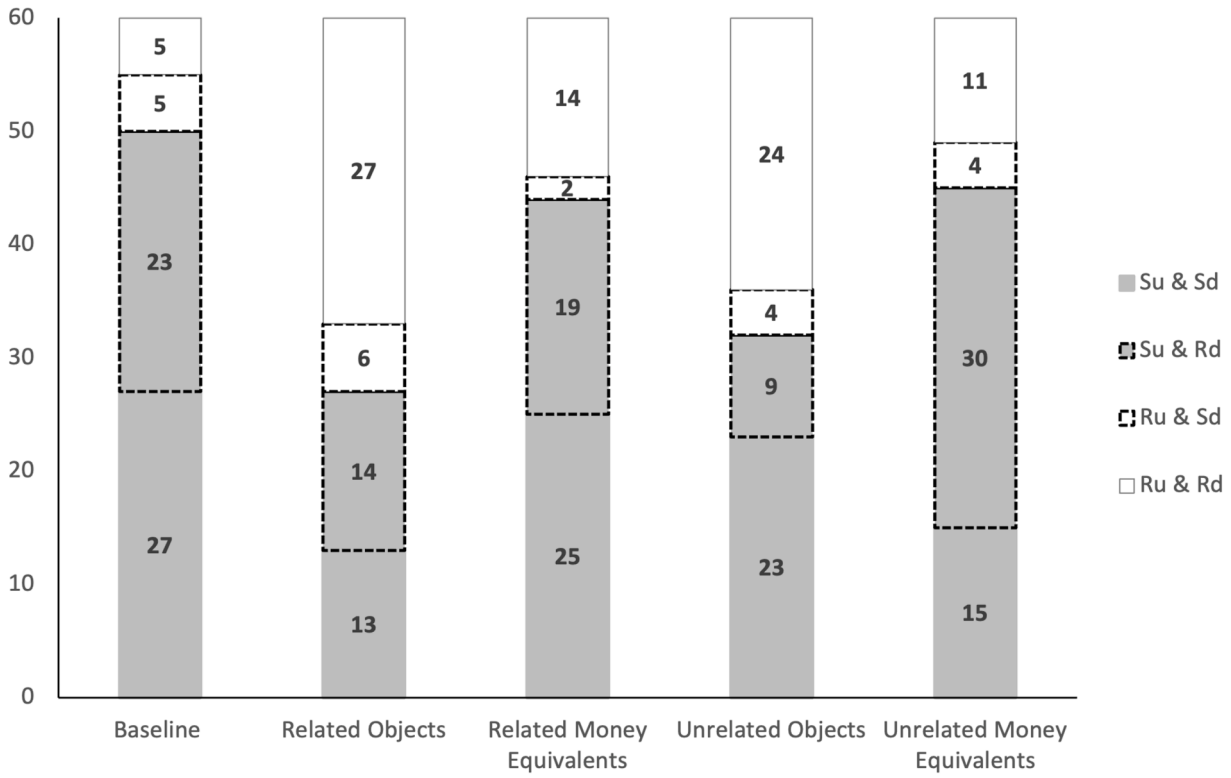


**Fig. 2.** Choice patterns by question set.
Note: Grey (white) background denotes an $S_u$ ($R_u$) choice in the scaled-up pair. Dashed sections denote EUT-inconsistent choice patterns. Numbers in each section are frequencies ($N = 60$).

choices between $S_u$ and $R_u$ are split approximately evenly.[3] Overall, with fewer safe choices in the scaled-up pairs involving objects, there is less potential for the CRE to occur.

Data collected via other choices faced by our participants[4] also display a greater prevalence of safer choices with monetary than non-monetary consequences. These data were in the form of probability equivalents, defined as follows. Consider any two goods $X$ and $Y$ with money equivalents $ME(X) > ME(Y) > 0$. Construct a risky prospect offering the most favored outcome with probability $p^*$ and 0 with probability $(1 - p^*)$. Under standard assumptions, there is some $p^*$ such that an individual is indifferent between receiving that risky prospect or receiving the intermediate outcome for certain. That $p^*$ is the probability equivalent. Other things being equal, the more risk averse the individual, the higher is $p^*$.

We elicited participants' probability equivalents for eight lotteries with different outcomes: two pairs of Related Objects, two pairs of Unrelated Objects, and their respective money equivalents (see details in Appendix C). We found that individuals exhibited greater risk aversion with money: cases where the $p^*$ for the money equivalents ($p^*_{ME}$) exceeded the $p^*$ for the corresponding objects ($p^*_O$) were significantly more frequent than the reverse, with a binomial test rejecting the null hypothesis of equal frequency between $p^*_O > p^*_{ME}$ and $p^*_O < p^*_{ME}$ at the 10% level of significance in every case and at the 5% level in three out of four cases: see Table 1.

**Table 1**
Evidence of greater risk aversion for money.

| | Number of cases | | | Binomial test p-value |
|---|---|---|---|---|
| | $p^*_O > p^*_{ME}$ | $p^*_O = p^*_{ME}$ | $p^*_O < p^*_{ME}$ | |
| Related Pair 1 | 14 | 11 | 33 | 0.0079 |
| Related Pair 2 | 16 | 7 | 35 | 0.0110 |
| Unrelated Pair 1 | 17 | 10 | 31 | 0.0595 |
| Unrelated Pair 2 | 15 | 8 | 35 | 0.0066 |

Note: Numbers of cases in which the probability equivalent of the lottery involving an object ($p^*_O$) was greater than, equal to or less than the probability equivalent of the lottery involving the object's money equivalent ($p^*_{ME}$). The last column shows the binomial test p-value of the null hypothesis that inequalities in the two directions are equally frequent.

## 4. Discussion

Our experiment was prompted by the concern that one of the seemingly most robust anomalies in choice under risk might not occur when the consequences of the lotteries are non-monetary. Do people process non-monetary choices differently, challenging the external validity of money as the appropriate experimental payoff to test models of decision making in the world at large? Our results add to recent evidence that this could be the case.

In the context of risky choices, DeJarnette (2017) observed that people exhibited substantially less risk aversion in choices involving goods than in comparable choices involving money (in the form of Amazon.com credit). More broadly, growing evidence suggests that risk aversion is stronger when outcomes are more easily compared. Schneider et al. (2020) compared risk taking with a single type of snack vs. snacks from different categories and found that participants chose the safe option more often in the former case. Read et al. (2023) reported

[3] This results in significant differences in the overall choice patterns: a $\chi^2$ test rejects the null hypothesis of no difference between choice patterns for money and objects in both the Related ($p = 0.0137$) and the Unrelated ($p = 0.0005$) cases.

[4] See Arroyos-Calvera (2018).

similar evidence, with individuals exhibiting greater implied risk aversion (as well as steeper time discounting) when trade-offs involved identical goods than when those goods differed qualitatively. Since risky choices for monetary lotteries involve outcomes that only vary in magnitude and not in other ways, this is in line with the difference we observe between money and objects in the CRE.

These findings suggest that the way people process different kinds of consequences may have important implications for decision making. EUT and many of the alternative models that have been proposed to explain robust anomalies such as the CRE assume that assigning a utility or a subjective value to each consequence of alternative courses of action results in choices that are independent of the various contextual features of the decisions facing individuals. This idea is a neat theoretical abstraction that has the advantage of greatly simplifying the analysis of decisions, but it is one that may omit important features of the ways that decisions are made in reality.

The growing evidence that differences between outcome characteristics may systematically affect risk attitudes calls for an investigation of plausible mechanisms. For instance, it may be that different consequences affect the noisiness of decisions, reducing the prevalence of either safe or risky choices. Alternatively, as suggested by Arroyos-Calvera et al. (2018), when the outcomes of risky prospects differ more in terms of characteristics, less attention may be paid to probabilities, resulting in lower risk sensitivity compared to choices between options where the degree of risk is more prominent, an account consistent with the attentional dilution effect proposed by Read et al. (2023).

More generally, there is great scope for further investigations of preferences using stimuli that reflect the complexity of real-world decisions more adequately than can be achieved with simple monetary lotteries. Such studies may stimulate the development of models of how economic agents approach their choices in a world where attention and the processing of multi-attribute options may play a greater role than standard models assume.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgments

We are grateful to the Leverhulme Trust for their financial support (Grant Number RP2012-V-022). Danae Arroyos-Calvera and Rebecca McDonald also received support from the Economic and Social Research Council (ESRC; grant number ES/R005893/1). Graham Loomes also received support from the ESRC's funding of the Network for Integrated Behavioural Science (Grant Numbers ES/K002201/1 and ES/P008976/1).

We would like to thank Tyson Hayes for his invaluable contribution programming the experiment interface. Also, Tigran Melkonyan, Zvi Safra, Matteo Galizzi, and the participants of the 2017 Subjective Probability, Utility and Decision Making conference, the 2018 Foundations of Utility and Risk conference, and the 2019 Royal Economics Society annual meeting, Behavioural Decision Sciences (BeDS) Workshop in Loughborough, and Early Career JDMx meeting in Trento for valuable comments.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.econlet.2024.112034.

## Data availability

Data linked on a footnote.

## References

Allais, M., 1953. Le comportement de l'homme rationnel devant le risque, critique des postulats et axiomes de l'école américaine. Econometrica 21, 503–546.

Arroyos-Calvera, D., 2018. *Exploring the Elicitation of Value: Life, Health and Consumer Goods* (Doctoral Dissertation). University of Warwick, Coventry, United Kingdom.

Arroyos-Calvera, D., Isoni, A., Loomes, G., & McDonald, R. (2018). The common ratio effect with objects and money. *Foundations of Utility and Risk, Book of Abstracts*. https://www.furconference.org/wp-content/uploads/2018/07/Book-of-Abstracts-2.pdf.

Blavatskyy, P., Panchenko, V., Ortmann, A., 2023. How common is the common-ratio effect? Exp. Econ. 26 (2), 253–272.

DeJarnette, P., 2017. Risky Choices Over goods. Working paper. University of Pennsylvania. Available at https://mackinstitute.wharton.upenn.edu/2017/risky-choices-over-goods/.

Kahneman, D., Tversky, A., 1979. Prospect theory: an analysis of decision under risk. Econometrica 47 (2), 263–292.

Keller, L.R., 1985. The effects of problem representation on the sure-thing and substitution principles. Manage. Sci. 31 (6), 738–751.

Read, D., McDonald, R., Cubitt, R., 2023. Comparison-specific preferences: the attentional dilution effect for delay and risk. J. Behav. Decis. Mak. 36 (5), e2348.

Schneider, M., Deck, C., & DeJarnette, P. (2020) Categorical salience theory. Economic Science Institute Working Papers – Chapman University. Available at: https://digitalcommons.chapman.edu/cgi/viewcontent.cgi?article=1301&context=esi_working_papers.