Do we share the cake? Experimental evidence of inequality aversion in real options games

Azzurra Morreale[1], Luigi Mittone[2], Mostafa Goudarzi[2], Flavio Bazzana[2]

[1] LUT, Business School, Lappeenranta-Lahti University of Technology, Yliopistonkatu 34, 53851 Lappeenranta, Finland

[2] Department of Economics and Management, University of Trento, Via Inama 5, 38122, Trento, Italy

EXTENDED ABSTRACT

Most studies aiming at understanding the business decision making process assume that individuals are fully rational agents. That is, when making decisions, they are expected-value-maximizing agents (Murphy et al., 2016), able to play Bayesian Nash equilibrium and selfish - i.e., they care exclusively about their payoffs (Goldfarb et al. 2012). On the contrary, a growing number of studies have documented that such assumptions are systematically violated. Accordingly, advanced models with alternative utility functions taking into consideration bounded decision-makers have been developed and tested (for a review see Goldfarb et al. 2012). Among these, utility functions that consider social preferences like fairness and inequality have gained popularity because they may explain how people behave in different contexts (Dula and Größler, 2020).

Fairness concerns are especially important in business relationships where "*there is a significant incidence of cases in which firms, like individuals, are motivated by concerns of fairness*" (Kahneman et al. 1986, p. S287). For instance, a growing body of operation management literature has been investigating the role of fairness in the context of supply chains (Dula and Größler, 2020).

Motivated by such evidence, in this research, we investigate the role of other-regarding preferences in a real options game (ROG) setting where people make decisions under both fundamental uncertainty due to the stochastic nature of payouts and strategic uncertainty due to potential rival responses (Morreale et al. 2019).

Specifically, we consider a typical ROG (leader–follower) Stackelberg game, where the investment of the leader does not entirely cut off the follower's revenues. We design a situation where the first player (leader) can decide either to choose a sure outcome that assigns a risky outcome to the second player (follower) or to delegate the decision to the follower. If the second player is given the possibility to decide, she can choose between a sure outcome, that is contingent on assigning a risky payoff to the leader, or the equal sharing of the risky outcome with the leader (let us refer to this alternative as "equitable alternative"). Three alternative scenarios of equilibrium solutions can be obtained by solving the game by backward induction, based on the values assumed by some of the model's input parameters. In this study, we only consider one potential equilibrium scenario: assuming decision makers to be risk-neutral and profit maximizers the Nash equilibrium is reached when the first mover selects the sure payoff assigning a risky outcome to the second player.

However, in this context, we argue that, when making decisions, individuals are affected by other-regarding preferences, that is they care not only about their own payoffs but also to payoffs going to the other player. Indeed, in a market where a few competitors interact, it is more likely that players avoid inequitable outcomes and prefer forgoing some monetary payoff to get more equitable outcomes (Fehr and Smith, 1999; Fehr & Schmidt, 2003; Dula and Größler, 2020).

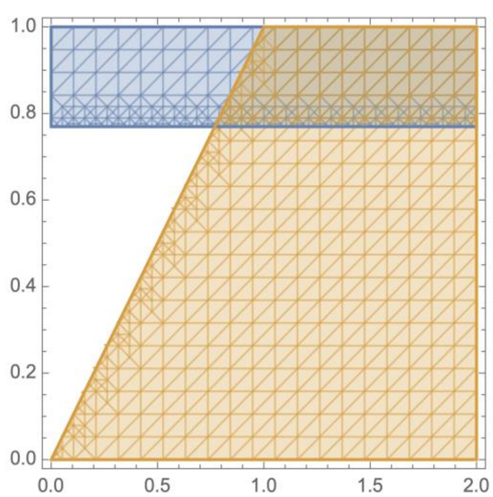
To mathematically account for this, we embed the inequality aversion function a' la Fehr and Smith (1999) in our ROG game. Formally, in the Fehr and Smith (1999) model the utility function is based on the difference between the payoff that player i gets (πi) and the payoffs the other subjects involved in the game get. Considering two players (i and j), the utility function has the following form:

$$U(\pi i, \pi j) = \pi i - \alpha[\max(\pi j - \pi i, 0)] - \beta[\max(\pi i - \pi j, 0)] \quad (3)$$

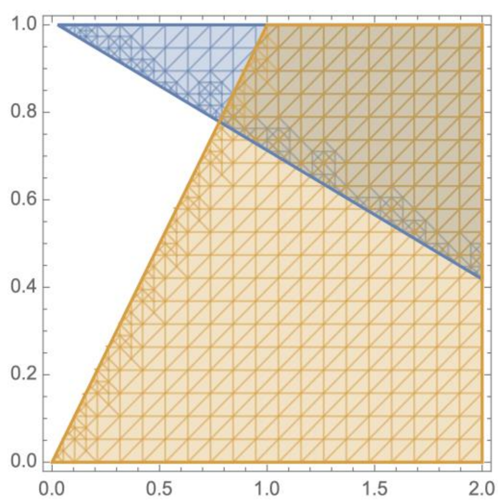
where πj is the payoff of player j. It is possible to observe that the utility is reduced when the player i's payoff is either lower or higher than the other player j's payoff, with the reduction being greater in the first case. That is, α reflects the disutility from an inequitable payoffs distribution that is disadvantageous to subject *i* (the so-called disadvantageous inequality or envy), while β reflects the disutility from an inequitable payoffs distribution that is advantageous to subject i (the so-called advantageous inequality or guilty) (Choi & Messinger, 2016). Fehr and Smith (1999) assume $\alpha \geq \beta$ and $0 \leq \beta < 1$. In other words, players exhibit a stronger disadvantageous inequality than an advantageous one.

Including the afore-mentioned inequality aversion utility in our real options setting, we find that for given values of α and β, both first and second movers have a higher utility when the equitable alternative is chosen, that is when they decide to equally share the outcome.

Moreover, as uncertainty increases, we find that the threshold of α and β in favor of the equitable option decreases, that is, even subjects with a lower level of inequality aversion tends to favor the equitable alternative. In other words, as uncertainty increases, it is more likely that people prefer the equitable alternative.



$\sigma = 0$



$\sigma = 0.27$

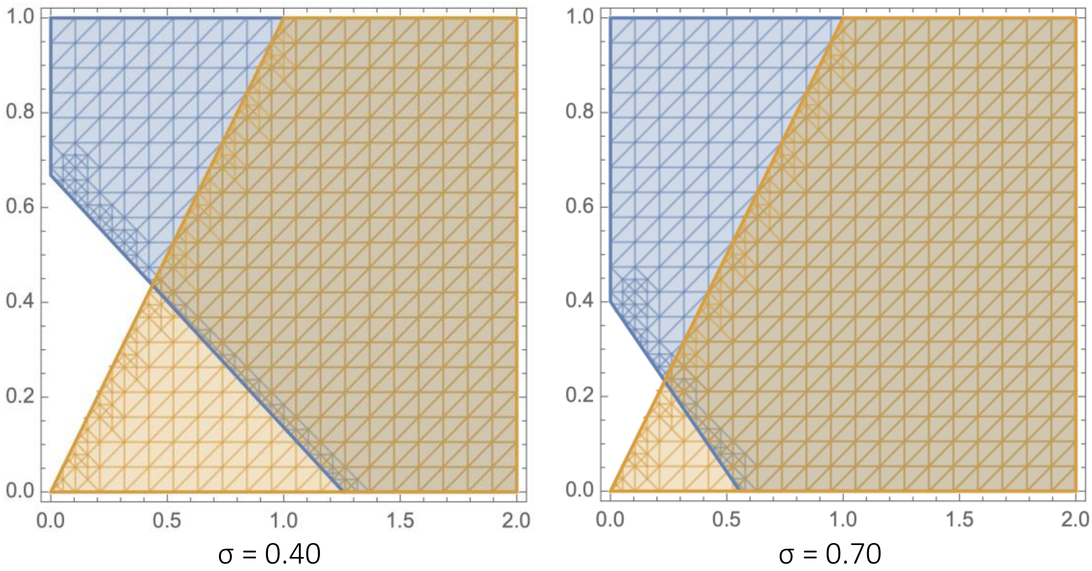


Figure 1: The threshold of alpha and beta by which someone choose equitable option for different level of uncertainty(σ)

Note: alpha is on the x-axis and beta on the y-axis; for the sake of simplicity, only alpha values up to 2 have been considered. The blue shading represents the beta range where the equitable option has a higher utility for different levels of alpha, whereas the orange shading represents the requirement that alpha be greater than beta. Where these two areas meet is the range in favor of the equitable option.

To complete the picture, we experimentally assess the afore-mentioned model with real human beings. This allows us to investigate whether people deviate from the standard rationality assumption in formal real option games and have instead inequality concerns. By doing so, we also contribute to an emerging stream of research that has adopted laboratory studies to test real options frameworks and shown that individual behavior deviates from Bayesian Theory (e.g., Driouchi, Trigeorgis, & So, 2020; Miller and Shapira 2004; Morreale et al. 2019; Murphy, Andraszewicz, & Knaus, 2016; Oprea et al., 2009; Yavas & Sirmans, 2005).

We run a first experimental pilot involving 52 subjects, who had to perform a main task and three additional tasks. The main task is created and carried out using the aforementioned investment problem. Half of the players play the role of the leader and are randomly matched up with others who play the role of follower. They maintain this role throughout the experiment. The leaders must choose between two alternatives: a sure outcome that assigns a risky outcome to the second player (follower) or allowing the follower to decide. If the follower is given the possibility to decide, she can choose between a sure outcome, that is contingent on assigning a risky payoff to the leader, or the equal sharing of the risky outcome with the leader ("equitable alternative"). In line with Morreale et al. 2019, we apply the strategy method and ask the followers to make decisions supposing that they were provided with the opportunity of choosing. Participants made their choices for several investment decision problems (rounds), where we manipulated uncertainty. To check for order effects, the decision problems were presented to the participants in random order.

Additionally, we elicit inequality aversion at the individual level following the approach suggested by Blanco et al. 2011, that is we implement the Ultimatum Game task and a Modified Dictator Game task to test the model of Fehr and Schmidt (1999). Specifically, the Ultimatum

Game is used to elicit the disadvantageous inequality (i.e., α, the "envy" parameter), while the Modified Dictator Game is used to elicit the advantageous inequality (i.e., β, the "guilt" parameter). Finally, we employed the Bomb Risk Elicitation Task (BRET; Crosetto & Filippin, 2013) to elicit risk preferences. To encourage participants to maximize their experiment results, the participants were offered financial rewards based on their performance in the experiment.

Our findings[1] show that as uncertainty increases, people in the role of leader are more willing to abandon an unfair sure outcome and pass the decision to the second player, who has the option to share the uncertainty equally. Figure 2 shows the sum of the participant in the role of a leader who chose to pass the decision to the second player with different levels of uncertainty. It is worth noting that the expected value of the outcome has been kept constant across different levels of uncertainty.

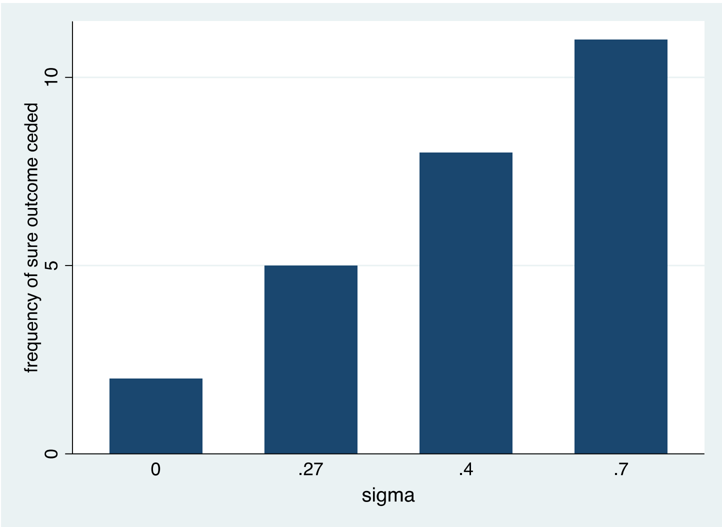


Figure 2: The number of times the sure outcome is ceded to delegate the decision to the second player across different levels of uncertainty (sigma)

Moreover, we introduced an incentivized beliefs elicitation technique aimed to verify if the first movers who decide to transfer the decision to the second player were expecting that the second mover would choose the equitable option. Coherently with our initial assumptions, many first movers declare that they are expecting the second mover will behave equitably.

We also found that people in the role of follower are more willing to select the equitable option as the uncertainty increases as Figure 3 reports.

[1] In this submission, we only show the results got under given input model's parameters. The results are robust even when we consider other values of the input model's parameters.

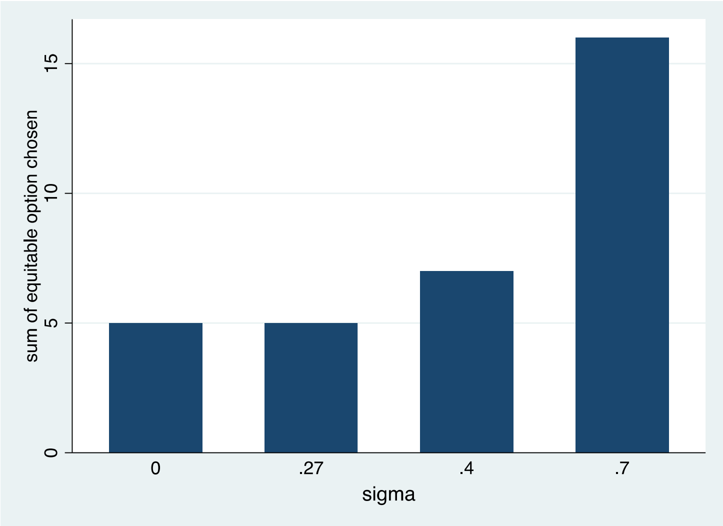


Figure 3: The frequency of equitable choices for different levels of uncertainty (sigma)

The findings are consistent with what we predicted theoretically in Figure 1, where we showed that as uncertainty increases, there is more room for choosing an equitable option, and thus even people with lower levels of inequality aversion will choose the equitable option.

References:

Blanco, M., Engelmann, D., & Normann, H. T. (2011). A within-subject analysis of other-regarding preferences. *Games and Economic Behavior*, 72(2), 321-338.

Driouchi, T., Trigeorgis, L., & So, R. H. (2020). Individual antecedents of real options appraisal: The role of national culture and ambiguity. *European Journal of Operational Research*, 286(3), 1018-1032.

Morreale, A., Mittone, L., & Nigro, G. L. (2019). Risky choices in strategic environments: An experimental investigation of a real options game. *European Journal of Operational Research*, 279(1), 143-158.

Choi, S., & Messinger, P. R. (2016). The role of fairness in competitive supply chain relationships: An experimental study. *European Journal of Operational Research*, 251(3), 798-813.

Crosetto, P., & Filippin, A. (2013). The “bomb” risk elicitation task. *Journal of risk and uncertainty*, 47, 31-65.

Goldfarb, A., Ho, T. H., Amaldoss, W., Brown, A. L., Chen, Y., Cui, T. H., ... & Yang, B. (2012). Behavioral models of managerial decision-making. *Marketing Letters*, 23(2), 405-421.

Đula, I., & Größler, A. (2021). Inequity aversion in dynamically complex supply chains. *European Journal of Operational Research*, 291(1), 309-322.

Fehr, E., & Schmidt, K. M. (2003). Theories of fairness and reciprocity: evidence and economic applications. In M. Dewatripont, L. P. Hansen, & S. J. Turnovsky (Eds.), Advances in economics and econometrics (pp. 208–257). Cambridge, United Kingdom: Cambridge University Press. https://doi.org/10.1017/CBO9780511610240. 008 .

Fehr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics*, 114 (3), 817–868. https://doi.org/10.1162/ 003355399556151

Kahneman, D. , Knetsch, J. L. , & Thaler, R. H. (1986). Fairness and the assumptions of economics. *Journal of Business*, 59 (4), S285–S300.

Miller, K. D. , & Shapira, Z. (2004). An empirical test of heuristics and biases affect- ing real option valuation. *Strategic Management Journal*, 25 (3), 269–284

Murphy, R. O. , Andraszewicz, S. , & Knaus, S. D. (2016). Real options in the laboratory: An experimental study of sequential investment decisions. *Journal of Behavioral and Experimental Finance*, 12, 23–39.

Oprea, R. , Friedman, D., & Anderson, S. T. (2009). Learning to wait: A laboratory investigation. *The Review of Economic Studies*, 76 (3), 1103–1124.

Yavas, A. , & Sirmans, C. F. (2005). Real options: Experimental evidence. *The Journal of Real Estate Finance and Economics*, 31 (1), 27–52.