ÁREA TEMÁTICA: Economia Comportamental – Teoria dos Jogos – Mercados Financeiros

MIND GAMES IN MARKET BUBBLES: EXPLORING SPECULATION THROUGH GAME THEORY

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RESUMO

Este estudo investiga se o raciocínio estratégico individual, medido a partir do jogo beauty contest, pode prever o comportamento especulativo em mercados com ativos sem valor fundamental. Foram conduzidos experimentos com 116 estudantes, que participaram sequencialmente do beauty contest game e de um experimento que simula a formação de uma bolha financeira (bubble game). A hipótese central era que participantes com maior grau de profundidade de raciocínio seriam menos propensos a adotar um comportamento especulativo. Os resultados, no entanto, apontam na direção oposta: o raciocínio estratégico demonstrado no beauty contest não se traduziu em decisões mais racionais no bubble game. Modelos estatísticos mostraram que o comportamento especulativo esteve mais associado à estrutura do jogo do que a características cognitivas. Participantes que demonstraram níveis mais altos de raciocínio em um contexto, muitas vezes não mantiveram esse padrão em outro. Essas evidências reforçam a noção de racionalidade limitada e sugerem que o raciocínio é altamente sensível ao contexto. Ao combinar dois jogos experimentais amplamente utilizados, este estudo contribui para o debate sobre a especificidade da racionalidade e seus efeitos sobre a tomada de decisão em mercados especulativos.

Palavras-chaves: comportamento especulativo, beauty contest, bubble game, racionalidade limitada, tomada de decisão.

ABSTRACT

This study investigates whether individual strategic reasoning, measured through the beauty contest game, can predict speculative behavior in markets with assets of no fundamental value. Experiments were conducted with 116 undergraduate students, who participated sequentially in the beauty contest and an experiment that simulates the formation of a financial bubble (bubble game). The central hypothesis was that participants with deeper reasoning would be less likely to speculate. The results, however, point in the opposite direction: strategic reasoning in the beauty contest did not translate into more rational decisions in the bubble game. Statistical models showed that speculative behavior was better explained by the internal structure of the bubble game than by any stable cognitive trait. Participants who reasoned strategically in one context often failed to maintain that level of reasoning in another. These findings reinforce the concept of bounded rationality and suggest that reasoning is highly context-sensitive. By combining two widely studied experimental games, this study contributes to the debate about domain-specific rationality and its role in speculative market behavior.

Keywords: speculative behavior, beauty contest, bubble game, bounded rationality, decision-making.

1 INTRODUCTION

Keynes believed that investors behaved like players in a newspaper beauty contest where participants should choose the six faces from one hundred photographs, they found the most attractive (KEYNES, 1936). The winner would be the one whose choice was closest to the average of all choices. Keynes argued that instead of choosing the faces participants personally found more interesting, players should opt instead for the pictures they believed most people found more attractive. Investors, in the same way, buy assets based on the expectation of other investors intentions of buying the same asset and often ignore their fundamental value.

This research adopts an empirical approach employing two quantitative experimental studies to explore the relationship between strategic behavior and speculative actions in financial markets, by analyzing the performance in the beauty contest game (NAGEL, 1995) and the behavior of participants in an experimental asset market prone to speculative bubbles (MOINAS; POUGET, 2013).

Statistical techniques were applied to assess whether high levels of reasoning, indicated by performance on the beauty contest game, correlated with reduced speculative behavior in the bubble game. This experimental design combines two established games in a novel way, investigating how individual reasoning levels correlate with speculative actions, therefore creating a pathway for exploring cognitive diversity in a financial setting and implications for market stability.

2 LITERATURE REVIEW

Bubbles arise when asset prices deviate from their fundamental value, driven by collective optimism and imitation rather than intrinsic value (KINDLEBERGER; ALIBER, 2005). Mass psychology shows how social sentiment can amplify optimism and fear, leading to stronger price swings (SHILLER; FISCHER; FRIEDMAN, 1984).

While collective forces like mass psychology contribute to speculative bubbles, behavioral game theory provides a framework for understanding how individual reasoning impact market behavior by explaining how individuals make decisions when they must anticipate the actions of others, particularly under uncertain conditions (CAMERER, COLIN F., 2003). A key concept of this approach is iteration steps: the mental process of forecasting others' decisions by thinking through multiple levels of reasoning (NAGEL, 1995). In this framework, individuals attempt to anticipate what others are likely to decide and then adjust their own choices based on these expectations. Each step of iteration adds a new level of reasoning, as individuals consider not only their own goals but also the beliefs and intentions of others.

In speculative markets, investors engage in varying depths of iterative thought, where each step involves an additional layer of anticipated reactions from others. This strategic foresight, or the ability to iteratively assess others' choices, introduces a cognitive approach that can either stabilize or intensify speculative trends.

This paper relies on the beauty contest game carried out by Rosemarie Nagel (NAGEL, 1995). In this scenario, players are asked to choose a number ranging from [0,100], aiming to get as close as possible to a fraction p of the average of all choices. This study sets p to 2/3; therefore, the winning number is 2/3 of the average of all chosen numbers in the interval [0,100]. This setup challenges players to anticipate the choices of others by thinking through multiple levels of reasoning, as each participant must consider not only their own choice but also the expected reasoning depth of others. According to (NAGEL, 1995), players using zero iteration steps might choose a random number, reflecting no consideration of others' choices. At the first iteration step, a player assumes that the average choice of others would be around 50, the expected choice of a player that chooses randomly, and then selects 2/3 of this value, resulting in 33. In the second iteration step, a player expects others to be strategic of degree one and therefore will select 2/3 of 33, resulting in 22. With each subsequent iteration, players add further layers of reasoning, progressively adjusting their choices downwards. As iteration approaches infinity, the number selected should reach 0, the rational solution (or Nash equilibrium) of the game.

This variation in reasoning depth highlights the diversity in strategic thinking between individuals, suggesting that those who engage in deeper iteration steps may be better equipped to anticipate collective behavior and therefore not engage in speculative behavior.

Experimental games have also explored how speculative bubbles can arise even in controlled environments. Research has shown that bubbles can develop when participants repeatedly trade an asset, often pushing prices above its fundamental value as social and psychological factors take precedence over rational calculation (SMITH; SUCHANEK; WILLIAMS, 1988). In a similar experimental setup, the bubble game (MOINAS; POUGET, 2016) investigates how speculative behavior unfolds when participants trade a hypothetical asset with fundamental value of zero that pays no dividends. In this game, replicated in this study, each player decides sequentially whether to buy such asset at a proposed price, hoping to resell it to the next participant at a profit, despite the asset's lack of intrinsic worth. In each round, the price increases tenfold, therefore, if a player is able to resell, they make a sure profit. Participants are not informed of their exact position in the sequence, which creates uncertainty about how many future players willing to buy remain. Over time, prices rise well beyond the asset's fundamental value, often collapsing when no new buyers emerge. Therefore, to choose rationally (i.e., not to buy the asset), players need to perform iterative steps of reasoning to anticipate the decision of other traders.

3 METHODOLOGY

3.1 Sample

The experiment was conducted over four weeks with undergraduate Business Administration students from FGV EAESP in Brazil. Five sessions were held across different semesters, totaling 116 participants. To prevent prior exposure bias, students from the 5th semester onward were excluded, as they had previously studied game theory. Participation counted as two hours of complementary activity credit[1]. Sessions lasted approximately 45 minutes and followed the same protocol, including explanation, data collection, and debriefing. The research procedures were approved by FGV's ethics committee[2].

[1] Students at FGV must have completed 300 hours of complementary activity by the 8th semester to graduate.
[2] Comitê de Conformidade Ética em Pesquisas Envolvendo Seres Humano da Fundação Getúlio Vargas

3.2 Bubble game framework

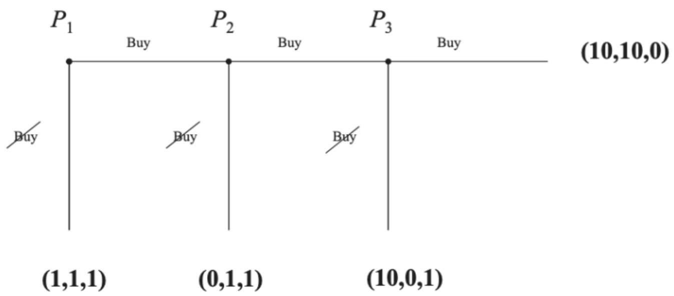
The bubble game was based on MOINAS; POUGET (2013, 2016) . Each market had three traders and an initial price P_1 drawn from a geometric distribution (1, 10, 100, 1,000, or 10,000) with probabilities of 1/2, 1/4, 1/8, 1/16 and 1/16, respectively. Each participant received an assigned price and a decision sheet (buy / not buy) identified by a unique ID number. For this experiment, there was a cap on the maximum initial price P_1 of 10.000. Once P_1 was assigned, the prices of the second and third traders were determined as $P_2 = 10 \times P_1$ and $P_3 = 100 \times P_1$.

3.3 Experimental procedure

Participants first completed the beauty contest game, by scanning a QR code that redirected them to a Socrative[3] room, an online student response platform, where they were asked to enter the ID number stapled on the back of their decision sheet. Once all students entered their ID, instructions for the beauty contest game were presented: each participant was asked to choose a number between 0 and 100, attempting to guess 2/3 of the average of the numbers submitted by all players.

Before beginning the second activity, students were instructed to turn over their decision sheets and pay close attention to the explanation of the game, which was presented using slides. Following the original experiment (MOINAS; POUGET, 2016), participants started the game with $1. They were allowed to borrow additional funds if needed in order to buy the asset with the understanding that any profits would be shared as follows: $\frac{1}{P_t}$ for the trader (i.e., the student) and $\frac{P_t - 1}{P_t}$ for the lender. Following this logic, for a trader that bought the asset for $P_t = 100$ and successfully sold it for $P_{t+1} = 1.000$, the profit distribution would be $\frac{1}{100} \times 10 \times 100 = 10$ for the trader and $\frac{100-1}{100} \times 10 \times 100 = 990$ for the lender. Thus, the maximum payoff of a successful resale was $10. Based on this structure the game has three possible outcomes: (1) a gain of $10 if the asset was successfully resold, (2) a "gain" of $0 if the asset was bought but not resold and (3) the maintenance of the initial $1 if the asset was not bought. The payoff logic is demonstrated in the figure below, extracted from MOINAS; POUGET (2016).

Figure 1 – Bubble game payoffs



Source: Extracted from Moinas; Pouget (2016)

During the explanation, the students were also made aware of the probability distribution of P_1 and the cap on its value of 10.000. Participants were told that their sequence position could be inferred indirectly from the offered price but not explicitly known. After

(FGV CEPH)

[3] https://www.socrative.com

making their buy or not-buy choice, responses were collected and matched with their beauty contest data for analysis

4 RESULTS

4.1 Theoretical background: NAGEL (1995) bounded rationality model

(NAGEL, 1995) introduced a framework for analyzing strategic depth thorough iterated reasoning steps. Rather than assuming fully rational behavior, as predicted by classical game theory, the model reflects a bounded rationality approach, suggesting that individuals operate at varying levels of strategic thought. As discussed previously, within the interval [0,100], a player is considered strategic of degree 0 if they choose 50. This choice corresponds to the expected value of a random selection from a symmetric distribution. A player of degree 1 assumes that most choose randomly (i.e. 50) and therefore selects 2/3 of that value, resulting in 33. A degree-2 player, in turn, assumes that others are degree-1 thinkers and therefore chooses 2/3 of 33, resulting in 22. This process continues iteratively, with each degree-n player believing that others are, on average, of degree n-1. Following this logic, classical game theory, therefore, suggests the Nash-equilibrium is 0.

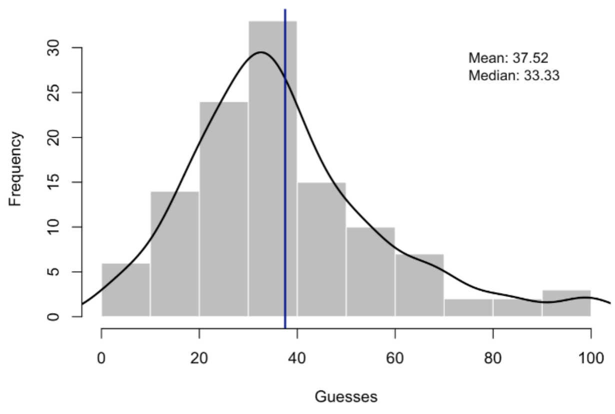
To classify participants responses that do not exactly match ideal iteration values (such as 33 or 22), the model defines intervals around each step-n value. These values take the form of $50 \times p^n$, where $p = \frac{2}{3}$ and $n = 0, 1, 2$ .... To distinguish between levels of reasoning, the boundaries between adjacent intervals are calculated using the geometric mean of two successive step values. For instance, the cutoff between level-0 (50) and level-1 (33,33) is set at the geometric mean of these two values, as follows: $\sqrt{50 \times 33{,}33} = 40{,}8$. Following this logic, a response between 40,8 and the next lower cutoff ($\sqrt{33{,}33 \times 22{,}22} = 27{,}5$)) would be classified as level-1 reasoning.

4.2 Empirical results

The beauty contest game in the current study involved 116 participants who each submitted a response for the 2/3 of the average game. The distribution if presented in

Figure **2**:

Figure 2 – Distribution of beauty contest game guesses ($p = 2/3$)



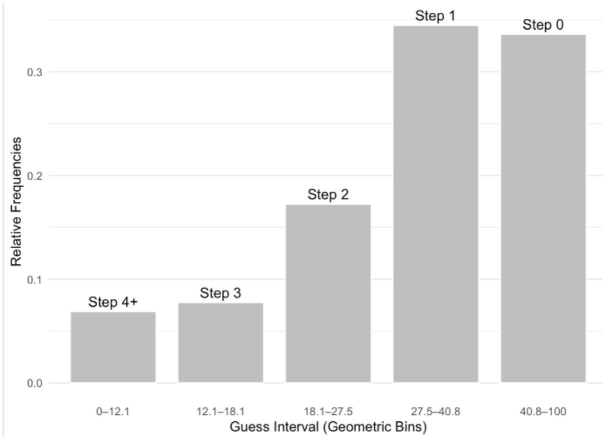
Source: Prepared by the authors based on empirical data using RStudio

The sample revealed considerable variation in strategic reasoning. The average guess was 37,52 – indicating that, on average, participants guessed values above the step-1 benchmark and well above the Nash equilibrium of 0. The median, however, was exactly 33,33 – aligning with the theoretical value associated with one level of reasoning. The higher mean indicates a right-skewed distribution, reflecting the influence of participants who chose very high values. This pattern closely reflects the results reported in NAGEL (1995), where the median was 33 and the mean, 36,73. The lowest guess was 1, very close to the Nash equilibrium, indicating a potential deep level of reasoning, while the highest guess of 100 might suggest a random response or possible misunderstanding of the game.

Using the step calculation explained earlier, participants guesses were grouped on intervals based on the geometric mean. As observed in

Figure 3, the distribution reveals a concentration of responses around step 1 (27,5 – 40,8) and step 0 (above 40,8), which together account for more than half of the sample. This mirrors the original findings where steps 0 and 1 also exhibited the highest relative frequencies. Responses within step 2 (18,1 – 27,5) also appeared in a substantial proportion, while guesses on or above step 3 (below 18,1) were fewer, suggesting that deeper levels of strategic thinking were less common.

Figure 3 – Relative frequencies by reasoning step



Source: Prepared by the authors based on empirical data using RStudio

4.3 From iteration to cognitive hierarchy

To extend Nagel's framework, the Cognitive Hierarchy (CH) model (CAMERER; HO; CHONG, 2004) assumes players' reasoning levels follow a Poisson distribution defined by a parameter τ, representing the average strategic depth. Higher-level players best respond to lower-level reasoning types, generating a hierarchy of responses. In earlier experiments, τ values typically ranged between 1 and 2 (CAMERER; HO; CHONG, 2004). In this study, $\tau = 1{,}22$, suggesting that participants engaged in just over one level of strategic thinking – consistent with prior research.

In the study by CAMERER; TECK; CHONG, 2003, the p-beauty contest game was conducted across a variety of different subject pools, with τ estimates between 0,1 and 3,8. The highest values were found among computer scientists and game theorists, while much lower estimates (around 1,0 – 1,2) were observed among CEOs, German students and older adults – which aligns more closely to the results of this study's sample (undergraduate students). Notably, the estimated τ of 1,22 is even lower than the value found in a sample of high school students ($\tau = 1{,}6$). This discrepancy may suggest difficulty understanding the game or limited engagement with the strategic reasoning it requires.

To apply the CH model to the data collected in this research, participants' guesses were first classified into five reasoning levels (steps 0 through 4) based on the geometric interval method introduced by NAGEL (1995). Each guess was assigned to a step following the cutoffs presented in Table 1, along with the frequencies observed in each level.

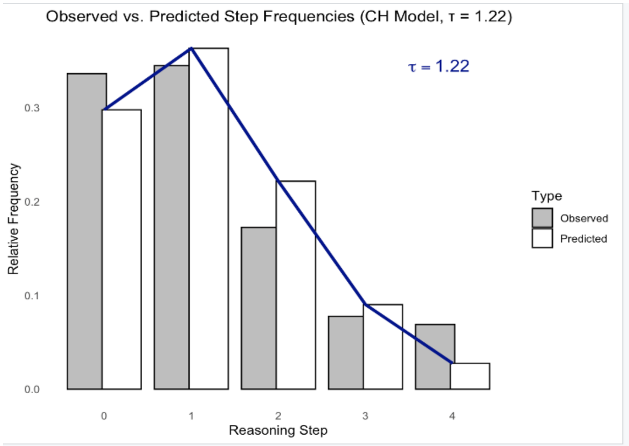
Table 1 – Reasoning step intervals and frequencies (Nagel classification)

Reasoning Step	Interval Range	Frequency
0	(40,8 - 100]	39
1	(27,5 - 40,8]	40
2	(18,1 - 27,5]	20
3	(12,1 - 18,1]	9
4	(0 - 12,1]	8

Source: Prepared by the authors based on empirical data

To estimate the value of τ based on this classification, the distribution of participants across steps 0 and 4 was compared to the Poisson probabilities based on the CH model. Since no guesses were above step 4, this estimation used a truncated Poisson distribution, where the total probability was normalized over the five observed steps. Using a maximum likelihood estimation procedure implemented in R, the value of τ that best matched the observed frequencies was identified ($\tau = 1{,}22$). Figure 4 compares the observed and predicted frequencies.

Figure 4 - Observed vs. predicted step frequencies (CH Model, $\tau = 1,22$)



Source: Prepared by the authors based on empirical data using RStudio

4.4 Theoretical background: backward induction and Nash equilibrium

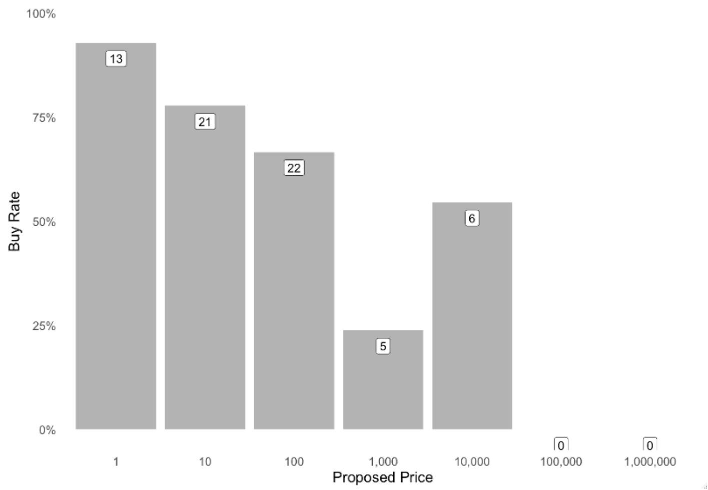
According to MOINAS; POUGET (2013), speculation occurs even in environments where rational behavior would predict otherwise. In this specific setting with a known price cap, the game can be solved by backward induction: the player who receives the highest price (in this case, 1.000.000) can deduce with certainty that he or she is the last in the sequence and therefore would choose not to buy. Anticipating that the last player will not buy, the previous player should also refuse to buy, and so on. This logic unfolds backward and leads to a unique Nash equilibrium in which no one accepts to buy the asset. This provides the theoretical benchmark for interpreting participants' speculative deviations from the rational equilibrium.

4.5 Empirical results

In the experimental setting, although the asset has no fundamental value, participants could profit from a resale, which would only occur if the following player also chose to buy. Therefore, choosing to buy implies a speculative expectation regarding the behavior of future participants. Figure 5 displays the proportion of "buy" decisions across all price levels. At the lowest value, 1, 93% of participants chose to buy, followed by 78% at 10 and 67% at 100. The buy rate dropped significantly to 24% at 1.000 but interestingly rose to 55% at 10.000, a price much closer to the last possible value of 1.000.000 and consequently where the risk of being last in the sequence was substantially higher. At 100.000 and 1.000.000, no participant chose to buy.

This behavioral pattern suggests that participants were influenced by more than just the logic of backward induction. While speculation becomes less frequent as price increases, the spike at 10.000 and the complete abstention at the final two prices indicate that other mechanisms, such as limited reasoning or subjective beliefs about the position in the sequence, may be affecting participants' choices.

Figure 5 - Speculative decisions by price level. White boxes indicate the absolute number of participants who chose to buy.



Note. White boxes indicate de absolute number of participants who chose to buy. Source: Prepared by the authors based on empirical data

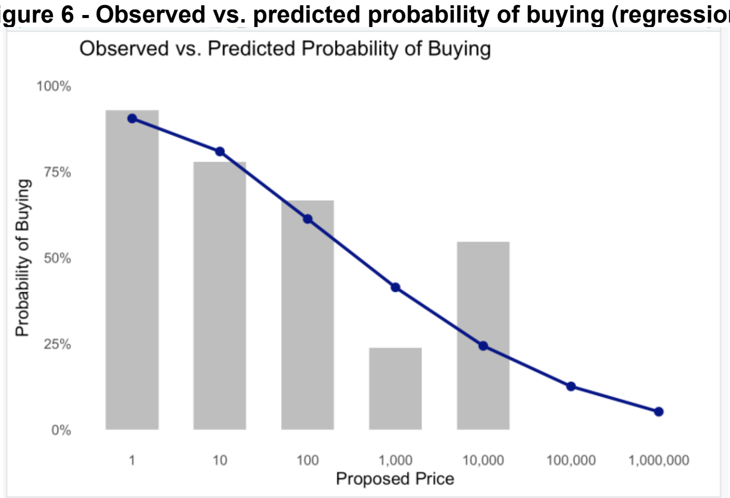
4.6 Reasoning steps, probability of being last, and the snowball effect

Building on MOINAS; POUGET (2013), speculative behavior can be explained by a "snowball effect,": the likelihood of buying increases with the number of reasoning steps needed to anticipate the collapse of the game and with the probability of not being the last in the sequence. These two elements suggest that early participants are more inclined to speculate, since the game structure makes resale more plausible and cognitive barriers to anticipating the end of the bubble are higher. To explain this behavior, the original research focused on two structure features of the game: (1) the number of reasoning steps needed to anticipate the end of the bubble and (2) the subjective probability of not being the last participant in the sequence. Additionally, the researchers considered a measure of risk aversion, which was not included in the present analysis.

The number of reasoning steps required at each price level reflects how far the participant is from the known initial price cap. It is computed as follows: $steps = \log(\frac{100 \times cap}{price})$. In this experiment, the cap was set at 10.000. The higher the number of steps, the more distant the participant is from the bubble's collapse, and the greater the cognitive effort involved in recognizing it. The second structural feature considered by this research is the subjective probability of not being last participant in the sequence. These values are assigned based on the price offered and follow the structure used in MOINAS and POUGET (2013). These probabilities reflect participants' potential beliefs about their position in the game based on the price they observe and were not disclosed to the students. Instead, they only had access to the predefined probabilities for P_1, as described previously.

A logistic regression was estimated using the binary buy decision as the dependent variable (1 for "buy" and 0 for "not buy"). For each participant, the number of reasoning steps and the probability of not being last were calculated based on the proposed price. The results, presented in Table 2, indicate that the number of reasoning steps was a positive and statistically significant predictor of buying behavior ($p = 0{,}020$), suggesting that participants were more likely to speculate when they were further away from the cap and required more reasoning to anticipate the end of the game. In contrast, the probability of not being last was not statistically significant ($p = 0{,}487$), indicating that this factor did not meaningfully influence the decision to buy in this sample. This may help explain the unexpected spike in purchases observed at the price cap of 10.000. While theory would predict hesitation at this level, given its proximity to the end of the sequence, and the 50% chance of being last, participants may have failed to incorporate this information into their reasoning. Moreover, 10.000 may have functioned as a psychological anchor due to its explicit mention as the maximum possible first price, making it appear more legitimate or "safe" as a buy price compared to the surrounding values. Figure 6 compares the predicted probabilities from the regression model with the actual frequencies at each price level.

Figure 6 - Observed vs. predicted probability of buying (regression)



Source: Prepared by the authors based on empirical data

A Pearson correlation analysis revealed a strong positive correlation between reasoning steps and the probability of not being last ($r = 0{,}79$), indicating that participants who reasoned further also tended to perceive themselves as less likely to be last in the sequence. While this level of correlation raises concern about multicollinearity, the Variance Inflation Factor (VIF) for both variables remained at 2,01. To further explore this issue, two separate logistic regressions were analyzed including each predictor separately. Both variables were statistically significant when included alone, but only reasoning steps remained significant when both were included together. This suggests that while both mechanisms relate to speculative behavior, reasoning steps play a dominant role when controlling for shared variance. Therefore, both predictors remained in the same model.

Table 2 - Logistic regression: determinants of buy decision

Variable	Coefficient ($\boldsymbol{\beta}$)	Standard Error	z-value	p-value
Intercept:	-2.90	0.71	-4.03	< 0.001
Reasoning steps:	0.80	0.26	3.11	0.0018
P (Not last):	0.31	1.23	0.25	0.8023

Source: Table prepared by the authors based on empirical data.
Dependent variable: Buy decision (1 = buy; 0 = no buy)
Model: Logistic regression (logit link)
Number of observations: $n = 116$

4.7 Cognitive hierarchy and quantal response equilibrium models

Extending the analysis, this section investigates whether broader behavioral models, influential in game theory literature, can explain the pattern of buy decisions observed in this experiment. Following the approach proposed by MOINAS; POUGET (2013), the CH model was used to simulate the distribution of strategic types in the sample and generate predictions of speculative behavior at each price level. When applied to the bubble game sample, the model yielded an estimated τ of 4,5 – higher than the 1,22 observed in the beauty contest game.

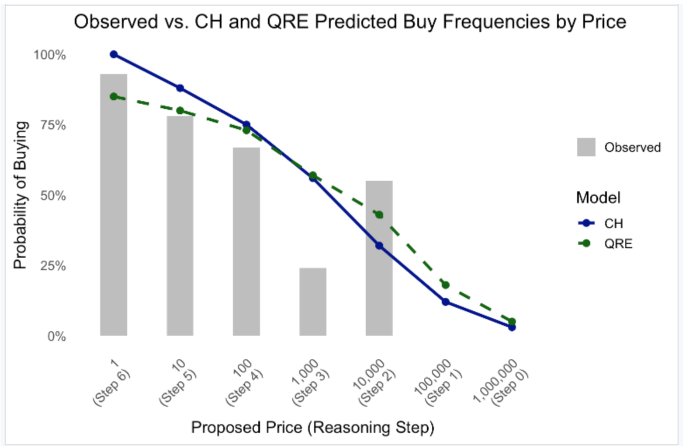
While in the beauty contest a higher τ reflects a population with deeper levels of strategic sophistication, in the bubble game, it instead indicates that speculative behavior is more frequent among participants positioned further from the price cap, when collapse was harder to anticipate and resale still seemed plausible. This estimate wildly contrasts with the τ of 1,1 reported in MOINAS; POUGET (2013), where speculative behavior was more concentrated near the price cap, requiring fewer reasoning steps. In the present sample, $\tau = 4{,}5$ reflects a broader distribution of speculation, with a significant share of participants entering at early price levels. This pattern supports the snowball effect and suggests that the CH model, when with a higher τ, correctly captures the tendency of speculation to arise from limited capacity to foresee the end of the game rather than a lack of reasoning.

To complement this analysis, the Quantal Response Equilibrium (QRE model) was also applied to the data, followingMOINAS; POUGET (2016). While the CH model assumes a distribution of reasoning steps, the QRE model considers all players as payoff-sensitive agents who respond probabilistically to incentives. The model includes a single parameter λ, which indicates the degree of responsiveness to expected payoffs: as λ increases, decisions become closer to best responses, while at low values of λ, choices are more random.

In the original study, λ was estimated by solving a fixed-point system based on the game's payoff structure (Figure 1). In this analysis, the same logic was implemented through a spreadsheet model provided by the researchers. For each price level, the expected utility of buying and not buying was computed based on the probability of resale and the known payoffs. The spreadsheet then used the logit formula to calculate the probability of buying at each price as a function of λ. This value was manually adjusted to minimize the difference between predicted and observed frequencies. The estimated λ value for this sample was 0,2, close to the 0,3 used by the authors to fit their data. In both cases, the low λ indicates that rather than responding deterministically to incentives, players appear to rely on imprecise reasoning when deciding whether to buy. This result reinforces that speculation in the bubble game is not the outcome of calculated optimization but emerges under conditions of limited clarity and bounded rationality.

Both the CH model and the QRE models were able to approximate the observed pattern of speculative behavior across price levels, but QRE provided a slightly better fit. The difference is reflected in the goodness-of-fit measures: QRE yielded a lower RMSE (0,155) and MAE (0,120) compared to the CH model where RMSE (0,166) and MAE (0,136) were higher. These results are consistent with the findings of (MOINAS; POUGET, 2013, 2016), who concluded that QRE better fit their sample. In this experiment, both models performed reasonably well, but the lower prediction of error of QRE suggests it provides a closer approximation of how participants interpreted the resale opportunities. A visual comparison of the predictions generated by each model is presented in Figure 7.

Figure 7 - Observed vs. CH and QRE predicted "buy" frequencies by price



Source: Prepared by the authors based on empirical data

5 DISCUSSION

5.1 Statistical comparison between games

While the previous sections analyzed the beauty contest and bubble game independently, this section explores whether the reasoning patterns observed in the first game relate to the decisions made in the latter. Since participants completed both tasks in sequence, using the same anonymous ID number, it is possible to directly link their responses and examine whether individual differences in strategic thinking help explain variation in speculative behavior. The goal is not only to test for consistency in reasoning steps across contexts, but also to investigate whether limited cognitive depth, captured by lower reasoning steps in the beauty contest, is associated with a higher likelihood of speculative choices in the bubble game. To do so, a series of regression models is presented. These include both direct tests of association and broader behavioral comparisons, allowing for a more complete view of how strategic reasoning translates across different decision environments. The following paragraphs detail the analysis of each model tested. Variables follow the description in Table 3.

Table 3 - Description of variables used in statistical models

Variable	Description
bubble_decision	Binary variable indicating the decision in the bubble game (1 = buy, 0 = not buy).
beauty_steps	Reasoning step assigned to the participant based on their guess in the beauty contest game.
bubble_steps	Number of reasoning steps required to anticipate the collapse of the bubble based on the offered price.
p_not_last	Subjective probability that the participant was not the last in the trading sequence, based on price.
irrational_speculator	Dummy variable equal to 1 for participants with high reasoning in the beauty contest (≥ 2) who chose to buy at or above 1,000.
step_difference	Difference between reasoning step in the beauty contest and in the bubble game.
score	Composite measure of speculative behavior across all price levels, lower values reflect higher speculation.
beauty_guess	Raw number (0-100) submitted by the participant in the beauty contest game.

Source: Table prepared by the authors based on empirical data

Model 1: $\boldsymbol{logit(\mathbb{P}(bubble_{decision})) = \beta_0 + \beta_1 \cdot beauty_{steps}}$

Do participants with higher strategic reasoning engage in contradictory speculative behavior?

The first model tests whether participants with higher levels of strategic reasoning in the beauty contest game were less likely to speculate in the bubble game. A logistic regression was estimated using the number of reasoning in the beauty contest as the sole predictor of the binary buy decision. The coefficient was negative as expected ($\beta = -0{,}032$), suggesting a slight decrease in speculative behavior as reasoning depth increased, but the effect was not statistically significant ($p = 0{,}838$). These results indicate that, when isolated, the reasoning level inferred from the beauty contest does not significantly predict speculative behavior in the bubble game. This finding may suggest that individual cognitive depth may not transfer across different game settings, particularly when the strategic environment and payoff structure are different.

Model 2: $\boldsymbol{logit(\mathbb{P}(bubble\_decision)) = \beta_0 + \beta_1 \cdot beauty\_steps + \beta_2 \cdot bubble\_steps + \beta_3 \cdot p\_not\_last}$

Does beauty contest reasoning matter after controlling for bubble-specific structure?

Model 2 includes two structural variables from the bubble game to the analysis: the number of reasoning steps needed to anticipate the end of the sequence and the subjective probability of not being last. Once these variables are included, the reasoning level from the beauty contest has no significant effect ($p = 0{,}848$). In contrast, the number of reasoning steps within the bubble game remains a strong and significant predictor of speculation ($p = 0{,}0018$). The probability of not being last is not significant ($p = 0{,}816$), suggesting that this belief had limited influence on the observed behavior. As calculated previously, all VIF values were analyzed and remained below 2,01 – confirming that multicollinearity does not bias the estimates. Overall, the results indicate that speculative behavior in the bubble game is driven more by its internal structure than by general strategic reasoning demonstrated in the beauty contest.

Model 3: $\boldsymbol{bubble\_steps = \beta_0 + \beta_1 \cdot beauty\_steps}$

Do participants who demonstrate deeper reasoning in the beauty contest also require more reasoning steps to anticipate the end of the bubble game?

Model 3 tests whether participants who exhibited higher levels of reasoning in the beauty contest game also faced more cognitively demanding positions in the bubble game, measured by the number of reasoning steps required to anticipate the end of the sequence. A simple linear regression was estimated with the bubble game reasoning steps as the dependent variable and the beauty contest steps as the predictor. The results show no significant relationship between the two ($p = 0{,}618$), with a very low coefficient ($\beta = -0{,}059$) and negligible explanatory power ($R^2 = 0{,}002$). These findings suggest that the level of strategic reasoning displayed in one game does not predict reasoning structure in the other, reinforcing the idea that behavior in the bubble game is shaped more by situational factors than stable cognitive traits across tasks.

Model 4: $\boldsymbol{logit(\mathbb{P}(irrational\_speculator)) = \beta_0 + \beta_1 \cdot beauty\_steps}$

Do participants with higher strategic reasoning engage in contradictory speculative behavior?

Model 4 examines whether participants with higher reasoning levels in the beauty contest were less likely to act in ways that contradict that profile when faced with speculative decisions. The binary variable ($irrational\_speculator$) was created to highlight cases in which a participant reached a step 2 or higher in the beauty contest and chose to buy the asses at price levels of 1.000 or above, points in the sequence where speculation becomes difficult to justify. Contrary to expectations, the regression reveals a positive and statistically significant relationship ($\beta = 0{,}735, p = 0{,}034$), indicating that a higher reasoning in the beauty contest was actually associated with a greater likelihood of engaging in this type of speculative behavior. This result suggests that participants who demonstrated strategic reasoning in one context did not necessarily apply that reasoning consistently in a different, more uncertain environment. It reinforces the view that reasoning patterns are highly context specific and strategic depth does not translate into caution under speculation.

Model 5: $\boldsymbol{logit(\mathbb{P}(bubble\_decision)) = \beta_0 + \beta_1 \cdot step\_difference}$

Is there a gap between reasoning in both games?

Model 5 tests whether the difference in reasoning steps between the games help explain participants speculative decisions. A new variable, ($step\_difference$), was created by subtracting the number of reasoning steps required in the bubble game from the number of reasoning steps assigned in the beauty contest. Positive values indicate participants reasoned more in the beauty contest than what their assigned position in the bubble game would suggest, negative values indicate the opposite. The results show a negative and statistically significant relationship ($\beta = -0{,}459\ p < 0{,}001$), meaning that participants who reasoned less in the bubble game relative to their own baseline in the beauty contest were more likely to speculate. This suggests that speculative behavior might be not merely a reflection of low reasoning overall, but rather of a drop in reasoning effort when moving between tasks. Students who applied fewer reasoning steps in the bubble game relative to their own performance in the beauty contest were significantly more likely to make speculative choices.

Model 6: $\boldsymbol{score = \beta_0 + \beta_1 \cdot beauty\_guess}$

Does the beauty contest guess predict overall speculative behavior?

To test whether participants' choices in the beauty contest game relate to their speculative profile, model 6 uses their raw guesses (from 0 to 100) as a predictor of the cumulative score derived from their decisions across all bubble game price levels. Higher scores represent less speculative behavior, while lower scores reflect a greater tendency to buy at riskier levels. The coefficient for the beauty contest guess is negative, as expected, but not statistically significant ($\beta = -0{,}007\ p = 0{,}601$). This suggests that participants who submitted higher values, indicating less strategic reasoning, did not, on average, behave more speculatively across the bubble game sequence. The R^2 value was near zero, indicating very little explanatory power. Overall, this result reinforces that individual reasoning styles in the beauty contest do not consistently translate to behavior in the bubble environment.

6 CONCLUSION

This study's objective was to investigate whether strategic reasoning, as measured in a coordination game like the beauty contest, could predict speculative behavior in a sequential asset market with no intrinsic value. While existing literature often treats rationality as a stable cognitive trait, the findings presented in this research suggest that reasoning appears to be highly context-dependent. Across six different statistical models, no consistent evidence was found that higher levels of reasoning in the beauty contest predicted a more cautious or rational behavior in the bubble game. In several specifications, reasoning depth in the beauty contest showed no significant association with speculation. In one model, it was even positively associated with riskier decisions. Notably, the model comparing each participants' strategic engagement across games revealed that speculation was more common among individuals who demonstrated a drop in reasoning effort between tasks.

This inconsistency supports the broader psychological insight that rationality is not general-purpose, but domain-specific (WANG, 1996). As with the Wason selection task, where individuals perform better when problems are framed in familiar or socially meaning terms (WASON, 1968), participants in this experiment seemed more accustomed to the immediate structure and framing of the bubble game than to an abstract reasoning ability developed in the beauty contest. The contrast between their performance in the two games emphasized the influence of context on strategic thinking.

From a behavior economics perspective, these findings reinforce the notion of bounded rationality (SIMON, 1955), not simply in the sense of limited cognitive capacity, but as a reflection of how individuals allocate their attention and reasoning efforts depending on the perceived stakes and structure of the task. In financial markets, this suggests that speculative behavior may not always come from a lack of intelligence, but from the way information and incentives are structured in the environment.

By combining two widely studied experimental games in a novel manner, this research contributes to the growing body of work that challenges the assumption of stable cognitive types. Strategic behavior does not travel well across contexts. Understanding this limitation is essential not only for behavioral modeling, but also for designing policies and environments that aim to mitigate excessive speculation and promote better decision-making in financial markets.

7 LIMITATIONS AND FUTURE RESEARCH

While this study offers new insights into the relationship between strategic reasoning and speculative behavior, it also presents limitations that open the door for future investigation. First, the sample consisted exclusively of undergraduate students from a single institution, which may limit the generalization of the findings. Participants were relatively homogeneous in terms of age, academic background and exposure to economics, potentially narrowing the variation in reasoning styles and risk preferences. Future research could extend this analysis to more diverse populations, including professional traders, older adults, or individuals from non-economic fields.

Second, the experiment relies on simplified representations of financial decision-making. While the beauty contest and bubble games are well-established proxies for strategic reasoning and speculation, they do not consider important features on real-world markets, such as social influence and repeated interactions. Introducing dynamic or repeated versions of these games in sequence could provide a richer understanding of how reasoning evolves over time.

Third, the study adopts a primarily cognitive approach. However, speculative behavior is also shaped by emotional, social and contextual factors not captured in this study. Future research could integrate additional dimensions, such as personality traits, confidence measures or group dynamics, to explore how cognitive and non-cognitive factors interact in speculation.

Finally, while this research focused on identifying statistical relationships across two tasks, experimental designs that manipulate framing or incentives could further explore other mechanisms underlying rationality. Such studies would be valuable in evaluating how environmental changes might help reduce speculation in real financial settings.

Beyond its academic contribution, the findings of this research are relevant for educators in economics and finance, behavioral researchers and professionals involved in the design of financial environment. Understanding that reasoning is context-specific rather than generalizable may help in designing better financial literacy tools, classroom experiments, and even regulatory mechanisms that account for how individuals actually behave under speculative pressure.

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