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Reevaluating the Rotten Kid Theorem: The impact of behavioral biases on family economic decisions

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Abstract

This paper reevaluates the Rotten Kid theorem by incorporating cognitive biases into its framework. The purpose is to understand how cognitive biases affect economic decision-making within the family unit, particularly when the decisions involve trade-offs between individual preferences and family welfare. A behavioral economics simulation is designed, factoring in various cognitive biases that could influence a hypothetical scenario in which a wife decides whether to disconnect a nightlight used by her husband. We introduce a novel "online in silico experiment" to communicate the hybrid nature of our research, encompassing both computational simulations and the utilization of online AI tools. The simulation monitors the contributions of the husband and measures the utilities of wife and husband over time, executing 1000 iterations. The simulations show that the husband's contributions decrease on average, and biases within the family cause varying and unpredictable effects on utilities. This contradicts the Rotten Kid theorem's prediction, indicating that selfish individuals may not always act to increase the overall family welfare when cognitive biases are present. This paper makes a unique contribution by applying behavioral economics creatively to a traditional economic theorem, improving understanding of family dynamics by incorporating psychological factors into the model, thus challenging the theorem and broadening the scope of behavioral economics in family economics.

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1. Introduction

The Rotten Kid theorem is an intriguing concept in family economics proposed by Gary Becker (1974; 1981). The theorem suggests that even a selfish family member (the “rotten kid”) will act in a way that benefits the family as a whole, as long as the family’s income is shared.

The theorem’s key points are: (1) Family head’s altruism: The theorem assumes that there is a benevolent family head who cares about the welfare of all family members and distributes the family income accordingly. (2) Self-interested behavior: Each family member, including the rotten kid, is assumed to be selfish and motivated purely by their own interests. (3) Shared income: The key to the theorem is that the family’s income is pooled and then distributed by the altruistic family head. This means the wellbeing of each family member is interconnected. (4) Incentives for cooperation: Even the rotten kid, who cares only about their own wellbeing, is incentivized to behave in a way that does not harm the family’s overall income. This is because any actions that hurt the family would, in turn, reduce the income that the family head can distribute to them.

As a result, despite their selfishness, the rotten kid’s actions inadvertently end up benefiting the family. This creates a situation where the selfish actions of the individual align with the welfare of the group. As an example, imagine a family where the parents distribute extra money among the children based on the family’s overall income. A selfish child, who might otherwise engage in harmful or noncooperative behavior, will refrain from such actions because it would reduce the family’s total income, and consequently, their own share of the money.

The theorem is logically valid and offers a valuable perspective on family dynamics, individual motivations, and economic behavior in terms of resource distribution within families. However, it oversimplifies human behavior and family interactions by assuming rationality and overlooking emotional, psychological, and social influences on individual actions in families. Additionally, it neglects cognitive biases, limiting its practical relevance in real-world family decision-making.

A major obstacle to conducting empirical studies on the Rotten Kid theorem is the difficulty of adequately assessing altruism and family dynamics. Rather of relying on direct empirical evidence, we choose to use the “online in silico experiment” outlined in Section 4. This can offer important fresh insights about how cognitive biases affect the economic decisions made by families. Though we concentrate on a simulation-based methodology, some features of the Rotten Kid theorem and related family economics concepts, including our behavioral perspective, have been indirectly tested through empirical research. Studies on family income pooling and altruistic conduct within families are a few examples.

Lundberg et al. (1997) investigate the issue of income pooling among families by looking at the UK’s Child Benefit, which is a cash benefit granted unconditionally to mothers for each child. The researchers find that families tend to pool their resources, as expenditure allocation does not alter significantly with benefit distribution, supporting the Rotten Kid theorem’s concept of income pooling. Cox and Rank (1992) explore the patterns of money transfers among families, viewing them as a type of intergenerational trading. The data imply that altruistic conduct plays an important part in financial transfers, with parents frequently financially supporting their children even after they reach maturity, showing the presence of altruistic reasons that correspond with the Rotten Kid theorem assumptions. Becker and Tomes (1986) study the role of human capital in family economic decisions, addressing issues of altruism and economic mobility within families. While their study does not explicitly test the Rotten Kid theorem, its empirical analysis provides insights into how families allocate resources, which is an important component of the theorem. Bernheim and Rangel (2009) present a theoretical framework for understanding how cognitive biases influence economic decision-making, especially in the context of family. They offer a choice-theoretic framework for behavioral welfare economics that allows for choice conflicts and other nonstandard behavioral patterns while not requiring economists to take a position on whether individuals have actual utility functions or how wellbeing should be assessed. While theoretical, their paper offers the framework for empirical research into how cognitive biases affect family economic decisions.

Becker uses the Rotten Kid theorem to illustrate a scenario involving a husband who enjoys reading at night, causing discomfort to his selfish wife due to the light. Although the husband, who loves his wife, reduces his reading time to make her happier, he still uses the light more than she prefers. One day, an electrician offers to secretly disable the light while the husband is away. Despite her dislike for the light, the wife should decline this offer. Becker argues that disabling the light, though unintentional from her husband's perspective, would be akin to a reduction in the family's overall wellbeing. This would lead the husband, who values his wife's happiness, to decrease the gifts he gives her, ultimately lowering her overall happiness more than if the light remained. Becker suggests that actions benefiting an altruistic individual indirectly improve the situation for their selfish counterpart, as the altruist's increased happiness prompts them to be more generous. In this case, the husband choosing the reading arrangements leads to an optimal outcome for both, unlike when the wife makes the decision, where no inherent incentive exists for her to choose an optimal solution for both without negotiating an explicit agreement.

The example fits into the Rotten Kid theorem, highlighting how altruism, self-interest, and Pareto optimality play out in family decision-making. It shows that a selfish person might act against their immediate interests to preserve benefits received from someone else's altruism, like the husband in this scenario. This demonstrates the intricate interaction between personal preferences, utility, and the distribution of resources in a family, where one member's actions impact the other's wellbeing. In this example, when the wife decides on the reading and light use, the result is not Pareto optimal, meaning a better arrangement exists that could benefit both her and the husband. The husband's decisions, on the other hand, are Pareto optimal as they consider the wellbeing of both partners. Pareto optimality, a key concept in welfare economics, describes a situation where improving one person's condition would worsen another's. The scenario also shows that without a clear agreement, the wife lacks motivation to choose an arrangement of the shared good (the light) that benefits both, emphasizing the need for communication and compromise in mixed-motivation relationships (altruistic vs. selfish). Applying the Rotten Kid theorem, the example suggests that a selfish family member (here, the wife) will not take actions that decrease overall family welfare, as it would also lower the benefits provided by the altruistic member (the husband). This is based on the assumption that the wife's happiness is directly linked to what the husband provides, influenced by his own happiness.

The Rotten Kid theorem's application in the nightlight scenario can be challenged by the wife's preferences and actions that prioritize values other than the husband's material contributions. Here we identify eight key deviations: (1) Valuing sleep more: If the wife values good sleep over the husband's gifts, she may choose to disconnect the nightlight, accepting fewer goods. (2) Alternative utility sources: Should the wife have other means of gaining utility or goods independent of the husband, disconnecting the light could be more appealing. (3) Nonmonetary value: If the wife values nonmaterial aspects like emotional support or companionship more, and these are not impacted by the light, she might opt to disconnect it. (4) Long-term benefits: The wife could anticipate that disconnecting the light might lead to long-term behavioral changes in the husband, eventually favoring her. (5) Changing dynamics: Disconnecting the light could alter the relationship's dynamics, potentially leading the husband to adjust his habits to accommodate her preferences. (6) Misjudging husband's response: If the wife incorrectly assumes the husband will not reduce his contributions, she might choose to disconnect the light. (7) Testing altruism: The wife might disconnect the light to test the husband's altruism, expecting him to continue or increase his contributions despite the inconvenience. (8) Negotiation leverage: Using the disconnection as leverage, the wife could renegotiate the relationship terms for a more favorable outcome.

2. Cognitive biases affecting the nightlight example

Cognitive biases can significantly alter decision-making, diverging from rational models like those in the Rotten Kid theorem. Here is how these biases might impact the previously mentioned eight scenarios in the nightlight example: (1) Endowment effect (Kahneman et al., 1990; Weaver and Frederick, 2012; Morewedge and Giblin, 2015): Valuing her current peaceful sleep too highly, the wife might disconnect the nightlight to maintain comfort, even if it is economically nonrational. (2) Overconfidence bias (Lichtenstein et al., 1982; Pallier et al., 2002; Moore and Healy, 2008): The wife could overestimate her ability to replace the husband's contributions, thinking substitutes are more available or valuable than they are. (3) Hyperbolic discounting (Thaler, 1981; Laibson, 1997; Grüne-Yanoff, 2015): Preferring immediate nonmonetary benefits like emotional support, the wife may undervalue future monetary gains, favoring short-term rewards. (4) Projection bias (Trofimova, 1999; Hsee and Hastie, 2006; Trofimova, 2014): Believing the husband will change his reading habits to suit her preference may stem from projection bias, wrongly assuming his future preferences will match her current ones. (5) Status quo bias (Baron, 1994; Kahneman et al., 1991): Disconnecting the light to create change, the wife might underestimate the husband's preference for the current situation and overvalue the benefits of a new balance. (6) Optimism bias (Baron, 1994; Hardman, 2009; Sharot, 2011; O'Sullivan, 2015): Underestimating the likelihood of negative outcomes, the wife might think disconnecting the light will not reduce the husband's contributions. (7) Gambler's fallacy (Tune, 1964; Darke and Freedman, 1997; Oppenheimer and Monin, 2009): If disconnecting the light is a test of altruism, she might wrongly assume past generosity ensures future generosity, similar to the gambler's fallacy. (8) Anchoring bias (Tversky and Kahneman, 1974; Fudenberg et al., 2012): Using the light's disconnection as a bargaining tool, the wife may anchor on this initial loss as a reference point, possibly overvaluing its negotiation importance.

These examples of cognitive biases illustrate that people do not always follow the path of economic rationality. Their choices are frequently shaped by psychological influences, causing them to deviate systematically from what traditional economic models would predict. This is where behavioral economics comes into play. It aims to weave these cognitive biases into the fabric of economic theory, providing a more accurate and realistic understanding of real-world behaviors.

3. Modeling the behavioral nightlight example

To show the failure of the nightlight example through a model incorporating the cognitive biases above, we simulate decision-making scenarios in a model that includes these variables: (1) Husband contribution, both monetary and nonmonetary. (2) Wife utility, reflecting her satisfaction from the husband's contributions and other factors. (3) Nightlight utility, representing the husband's benefit from reading with the nightlight. (4) Sleep utility, the wife's benefit from sleeping without the nightlight. (5) Substitutes utility, indicating the wife's benefit from alternative activities or sources.

Parameters in the model represent the intensity of each cognitive bias, and randomness is introduced to mimic human behavior variability. Decision functions are critical, as they simulate the wife's decision-making process regarding the nightlight, factoring in her perceived utility and biases. In the simulation, the wife repeatedly decides about the nightlight across different nights, each representing a chance to act on her biases. We accumulate these decisions to analyze the overall utility for both spouses over time.

The outcome is measured by tracking changes in husband's contribution and wife's and husband's utilities across iterations. This assessment reveals if and when the situation becomes Pareto optimal or if the nightlight example is valid.

4. Simulating the behavioral nightlight example

We present a novel approach to research methodology, dubbed online in silico experiment, to explain the mixed-methods character of our study, which includes both online AI tools and computational simulations. We predict the parameter values of our model as though questionnaires were given to real people, using trends from behavioral economics research. We tasked ChatGPT 4 with calibrating hypothetical parameter values based on the cognitive biases identified in current literature. The results are presented in Table 1.

Table 1. ChatGPT's prediction of parameter values.

Cognitive bias	*Prediction*
Endowment effect	Strong (people will likely overvalue their current comfort)
Overconfidence bias	Moderate (people tend to be somewhat overconfident in their abilities and resources)
Hyperbolic discounting	Strong (immediate comforts are often heavily favored)
Projection bias	Moderate to Strong (people may expect others to adapt to their preferences over time)
Status quo bias	Moderate (people often prefer the current state but can be motivated to change with sufficient incentive)
Optimism bias	Moderate (people may expect positive outcomes more than is warranted)
Gambler's fallacy	Low to Moderate (not all individuals are familiar with probabilistic outcomes)
Anchoring bias	Strong (initial information heavily influences decision-making)

We questioned ChatGPT how it made the parameter predictions shown in Table 1 and used in the model simulations (Section 5 and Appendix). We learned that it conducted a literature review and analysis. ChatGPT's responses are generated using training data that comprises a wide range of texts from the internet, books, journals, and research up to the last update. When recommending parameter values for cognitive biases, ChatGPT relies on published research findings, theoretical models, and empirical studies from psychology, behavioral economics, and decision sciences. Furthermore, ChatGPT's training incorporates data from research that measure the effects of various cognitive biases. For example, it might use data from experiments to assess the effects of the endowment effect, overconfidence, hyperbolic discounting, and other cognitive biases on decision-making. These studies frequently include numerical values or ranges that can be used to determine the degree of bias. In addition, theoretical issues are important. Some parameter values may also be derived from theoretical models that describe behavior under the impact of specific biases. For example, behavioral economics models that demonstrate how overconfidence or projection bias can influence investment decisions or savings behavior may recommend specific parameter strengths. Consensus in research is also examined. For well-studied biases, such as the endowment effect or hyperbolic discounting, there may be a consensus or a range of values found in several research. ChatGPT suggests values within these ranges based on its evaluation of the overall data.

Our proposed online in silico experiment methodology makes use of these features. Thus, we have created a simulation using the ChatGPT's specified parameters to represent the wife's decision-making in the nightlight scenario, incorporating the cognitive biases. The simulation tracks the husband's contributions and the utilities of wife and husband over time. Because these parameters are hypothetical, based on common findings in behavioral economics, the simulation is illustrative rather than predictive.

In our simulation, each iteration represents one night, running for 1000 nights. It simulates the wife's daily decision to disconnect the nightlight, influenced by her cognitive biases. The husband's response and his contributions vary based on her decision. We monitor the frequency of the nightlight remaining connected and its effect on the wife's utility. After completing the simulation, we analyze and present the descriptive statistics of the results.

In the simulation, the wife nightly chooses to keep or disconnect the nightlight, considering her sleep quality, husband's responses, and her own cognitive biases. Python is used for this simulation (Appendix), generating outcomes' descriptive statistics. The code models this for various wife's choices with differing cognitive biases. The np.random.uniform (0, 1) function in Python creates random values for sleep quality and contributions, reflecting diverse preferences in a population. After 1000 simulations, the results provide insights into typical outcomes, including average utilities for the wife and husband, and the husband's average contribution. The following section describes the model that underpins the simulations.

5. Model

Definitions:
U_h: utility of the husband
U_w: utility of the wife
C_h: contribution of the husband
V_s: wife's utility from sleep
V_g: wife's utility from husband's contributions
B: set of bias adjustments

Bias strength parameters:
b_{ee}: endowment effect
b_{oc}: overconfidence
b_{hd}: hyperbolic discounting
b_{pb}: projection bias
b_{sq}: status quo bias
b_{ob}: optimism bias
b_{gf}: gambler's fallacy
b_{ab}: anchoring bias

Utility calculation:
1. Initial settings
C_h =1.0 (initial contribution level of the husband)
V_s = Uniform (0,1) (wife's value for good sleep, drawn from a uniform distribution)
V_g = Uniform (0,1) (wife's value for husband's contributions, drawn from a uniform distribution)

2. Adjustments for overconfidence and projection bias in valuing goods:
If overconfidence bias occurs: $V_g = V_g(1 + b_{oc})$
If projection bias occurs: $V_g = V_g(1 + b_{pb})$

3. Adjustments for cognitive biases influencing sleep utility:
If endowment effect occurs: $V_s = 1.2V_s$
If hyperbolic discounting occurs: $V_s = 1.5V_s$

4. Adjustment for status quo bias reducing husband's contribution:
If status quo bias occurs: $C_h = 0.9C_h$

5. Decision making with optimism bias:
Disconnect light decision: $D = V_s > V_g$
If D is true (disconnect light):
    Decrease factor due to optimism bias: $df = 1 - b_{ob}$
    If anchoring bias occurs: $df = df(1 - b_{ab})$
    Adjust husband contribution: $C_h = C_h \cdot df$
Else (do not disconnect light): $C_h = C_h(1 + b_{pb})$

6. Final utilities:
U_w: If D is true, then V_s; else, V_g (wife's utility is based on the decision to disconnect the light or not)
$U_h = C_h + 0.5U_w$ (husband's utility is a function of his contribution and half of his wife's utility).

6. Simulation results

From 1000 simulations, we observed the following key statistics: (1) Husband's contributions: On average, contributions were 0.92, varying widely from 0.23 to 1.5. This wide spread, with many values below 1, suggests cognitive biases often led to reduced contributions. (2) Wife's utility: The average utility stood at 1.16, with a significant spread (0.04 to 2.55), highlighting the variability in the wife's satisfaction due to her decisions based on cognitive biases. (3) Husband's utility: Averaging at 1.49 with values ranging from 0.25 to 2.67, the husband's utility also varied greatly, showing the impact of his contributions and the wife's utility on his satisfaction.

The simulations reveal that the husband's average contributions dropped to 0.92 from an initial level of 1.0, highlighting instances of reduced contributions. This pattern deviates from the Rotten Kid theorem, showing that cognitive biases can alter decision-making, leading to outcomes that may not improve family welfare. Such findings challenge the theorem's notion that self-interest alone will boost family income, especially in light of decisions like the wife's about the nightlight.

Figure 1's histogram shows two main peaks in the husband's contribution levels, indicating varied responses. The first peak, at the lower end, reflects reduced contributions, likely due to cognitive biases such as the status quo bias. The second peak, at the higher end, shows maintained or slightly increased contributions. This bimodal distribution showcases the diverse effects of cognitive biases on the husband's reactions to the wife's decision to disconnect the nightlight.

Figure 2's histogram of the wife's utility presents a mostly uniform distribution with a lean towards higher values, illustrating wide variability in outcomes due to her decisions based on cognitive biases. The tilt towards higher utilities suggests scenarios often favor her comfort and satisfaction, possibly due to biases like the endowment effect and hyperbolic discounting, regardless of her decision on the nightlight.

The husband's utility has a wide distribution that leans towards higher values, as seen by the histogram in Figure 3. This shows that his utility frequently remains high despite unpredictability brought on by his contributions and the wife's actions. This trend implies that even when his contributions decrease as a result of the wife's biased decisions, his utility—which is influenced by both his contributions and the wife's utility—can change significantly.

Together, these histograms illustrate the nuanced outcomes of family economic decision-making under the influence of cognitive biases. They draw attention to the variability and unpredictability in how biases can affect utilities within the family.

7. Discussion

Our simulation applies all cognitive biases at once for every decision-making step. This approach evaluates the combined impact of biases on the wife's decision to turn off the nightlight and its effects on both spouses' utilities. By simulating all biases together, it aims to mimic real-life situations where multiple biases simultaneously influence decisions, acknowledging that choices are typically shaped by complex interplays of various cognitive biases.

An alternative method involves conducting separate simulations for each bias to identify its distinct impact on decisions. This would clarify how each bias affects outcomes individually. However, it would not show how biases interact. The current online in silico experiment does not model how biases might relate or intensify each other. For example, overconfidence and optimism bias, both positive illusions, affect decisions differently. To capture their interactions, a more advanced method using multivariate distributions or adjusting the simulation to show how some biases strengthen or weaken others would be needed.

To further explore the role of each bias, one could: (1) Run simulations individually for each bias, setting one bias at a significant level and others at zero or baseline. This would reveal the specific impact of each bias on decision-making. (2) Examine interactions between biases by creating scenarios where two or more biases influence decisions together, like overconfidence moderated by anchoring bias. These approaches could improve understanding of cognitive biases' effects on family economic decisions and offer a more detailed critique of the Rotten Kid theorem.

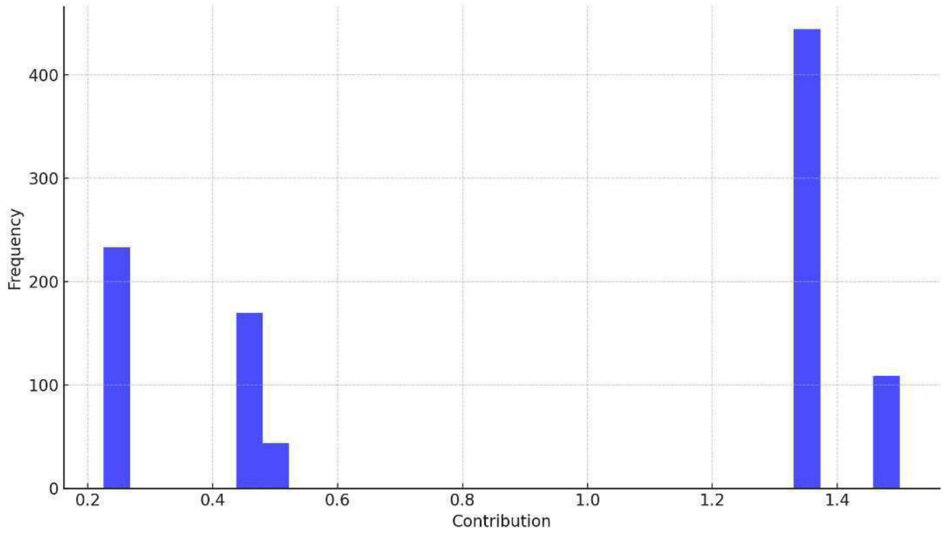

Figure 1. Histogram of husband’s contributions.

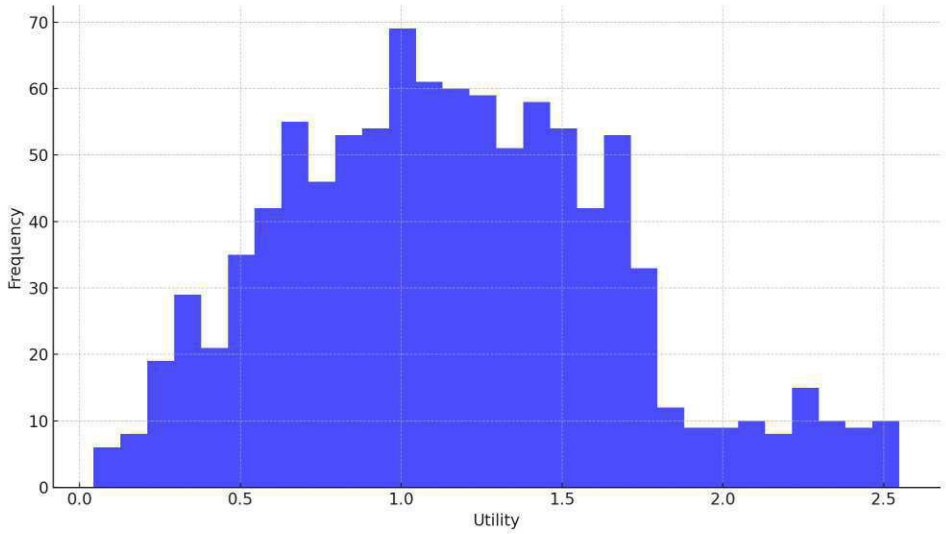

Figure 2. Histogram of wife’s utilities.

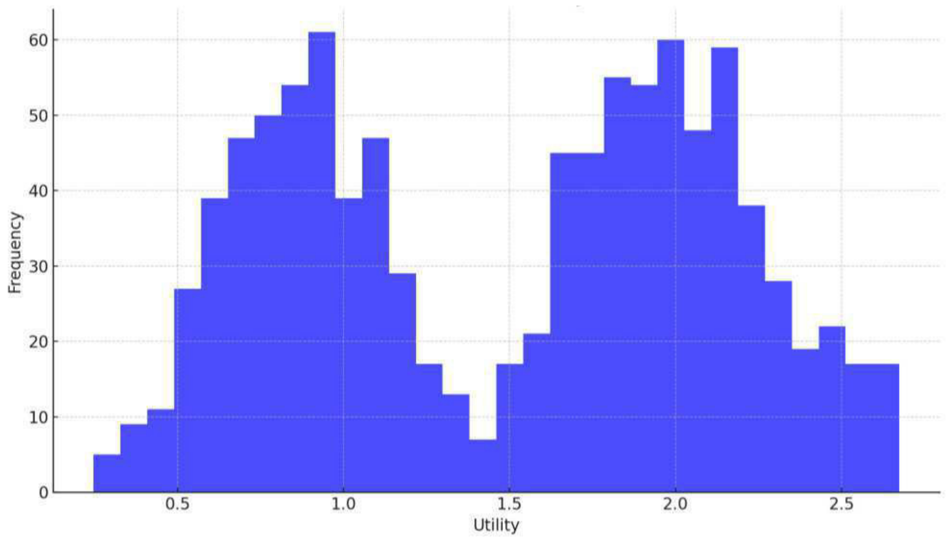

Figure 3. Histogram of husband’s utilities.

Regarding the classic and more recent literature, Bergstrom (1989) emphasizes the need for transferable utility in order for the Rotten Kid theorem to be applicable, as well as specifying particular utility function criteria for its validity. Gugl and Leroux (2015) build on Bergstrom's work on transferable utility by describing how kids can manipulate parental utility under specific conditions, supporting the Rotten Kid theorem in a broader setting. Cremer and Roeder (2014) look at three generations: young, middle-aged, and elderly. The middle-aged generation serves a dual function: they provide informal care for their aging parents while also investing in their kids' education. Education benefits the young, while the old may leave a gift to their kids. This interaction between families is depicted as a game that unfolds over time, with rotten kids becoming altruistic parents in the next cycle. The study finds that informal care, when set efficiently, corresponds with the Rotten Kid theorem for a single period. However, education investment is overly costly. Both education investment and informal care are inefficiently balanced in a long-term equilibrium, with education being too extensive and informal care being too limited. Because of overlapping roles and fluctuating dynamics within the family system, this suggests a distortion in generational exchanges of resources and care.

The Rotten Kid theorem has been linked to the Samaritan's dilemma, which is a paradox in which a charitable deed or a welfare policy meant to aid someone might have unanticipated negative repercussions, such as dependency or a reduced willingness to work. Dijkstra (2007) considers the Samaritan's dilemma and investigates a two-stage game including altruistic and selfish players, with the goal of determining the conditions under which altruism might lead to optimal results. According to Faria and Silva (2020), the optimality of power delegation in the sequential-action game played by rotten kids and a parent is critically dependent on the degree of heterogeneity in the kids' choices. Saito (2022) investigates the effect of parental uncertainty on monetary transfers, showing how increased ambiguity can lead to decreased kid effort and economic success. Forrest (2018) employs systems research to represent economic entities and validate the Rotten Kid theorem within this framework, thereby uncovering criteria for its broad applicability. Netzer and Schmutzler (2010) investigate a Rotten Kid model in which social preferences are determined by intentions rather than outcomes, emphasizing the intricacies of reciprocal behavior and its impact on material payoffs. Jürges (2000) investigates the timing of intergenerational transfers using rotten kids and Rawlsian parents, contrasting altruistic and Rawlsian parental preferences and their consequences for Pareto-efficiency.

We chose the most recent references from the extensive literature on the Rotten Kid theorem. Further references can be found on the references of these references. As can be seen, the existing literature primarily focuses on identifying the theoretical conditions under which the Rotten Kid theorem is valid, essentially undertaking an exercise in applied logic. Behavioral economics has transformed microeconomics into a genuine behavioral science rather than a mere mathematical exercise. Therefore, our work stands out as it uniquely evaluates the theorem within a behavioral framework, a perspective not previously explored. This distinctive approach, combined with our online in silico experiment strategy, is an interesting contribution to the literature.

8. Conclusion

This paper introduces a new approach termed online in silico experiment to build a model and simulation that evaluate how cognitive biases affect the Rotten Kid theorem. By modeling scenarios where a wife has to decide whether to disconnect a nightlight that her husband uses but which affects her sleep, the study captures the nuanced interplay of variables like husband’s contributions and utilities of wife and husband. The simulation, informed by behavioral economics, reflects the real-life unpredictability of human behavior and decision-making.

The findings illustrate the diversity and unpredictability of how biases affect family utilities. In particular, the simulation results show a decrease in the husband’s average contributions, contradicting the Rotten Kid theorem. This suggests cognitive biases can change decision-making, potentially harming family welfare. This challenges the theorem’s notion that self-interest always increases family income, as seen in decisions like the wife’s about the nightlight.

Economic decision-making is further complicated by cognitive biases, which are not taken into consideration in rational models such as the Rotten Kid theorem. While this theorem is logically correct, incorporating behavioral economics into the normative benchmark rational model leads to more ecologically accurate predictions and a better understanding of economic dynamics within families and other microeconomic units.

Appendix. Python script for simulating the nightlight behavior scenario.

```
import numpy as np
import pandas as pd

# Parameters for the simulation
n_simulations = 1000
bias_strengths = {
    'endowment_effect': 0.5,
    'overconfidence': 0.7,
    'hyperbolic_discounting': 0.8,
    'projection_bias': 0.5,
    'status_quo_bias': 0.8,
    'optimism_bias': 0.5,
    'gamblers_fallacy': 0.3,
    'anchoring_bias': 0.5
}

# Arrays to hold simulation results
husband_contributions = np.zeros(n_simulations)
wife_utilities = np.zeros(n_simulations)
husband_utilities = np.zeros(n_simulations)  # Add array for husband's utilities

# Run the simulation
for i in range(n_simulations):
    # Base utilities
    husband_contribution = 1.0  # Initial contribution level
    wife_utility_from_sleep = np.random.uniform(0, 1)  # How much she values good sleep
    wife_utility_from_goods = np.random.uniform(0, 1)  # How much she values husband's contributions

    # Adjust for overconfidence and projection bias in valuing goods or alternatives
    if np.random.rand() < bias_strengths['overconfidence']:
        wife_utility_from_goods *= 1 + bias_strengths['overconfidence']
    if np.random.rand() < bias_strengths['projection_bias']:
        wife_utility_from_goods *= 1 + bias_strengths['projection_bias']

    # Cognitive biases influencing sleep utility
    if np.random.rand() < bias_strengths['endowment_effect']:
        wife_utility_from_sleep *= 1.2  # She values her current comfort more
    if np.random.rand() < bias_strengths['hyperbolic_discounting']:
        wife_utility_from_sleep *= 1.5  # Prefers immediate comfort over future utility

    # Status quo bias reducing husband's contribution
    if np.random.rand() < bias_strengths['status_quo_bias']:
        husband_contribution *= 0.9  # She overvalues the status quo

    # Decision making with optimism bias
    disconnect_light = wife_utility_from_sleep > wife_utility_from_goods
    if disconnect_light:
        # If she disconnects the light, adjust for optimism and anchoring bias
        decrease_factor = 1 - bias_strengths['optimism_bias']
        if np.random.rand() < bias_strengths['anchoring_bias']:
            decrease_factor *= (1 - bias_strengths['anchoring_bias'])
        husband_contribution *= decrease_factor
    else:
        # If she doesn't, husband's contribution increases slightly
        husband_contribution *= (1 + bias_strengths['projection_bias'])

    # Update the utilities based on the decision
    wife_utility = wife_utility_from_sleep if disconnect_light else wife_utility_from_goods
    husband_utility = husband_contribution + 0.5 * wife_utility  # Example utility calculation for husband

    husband_contributions[i] = husband_contribution
    wife_utilities[i] = wife_utility
    husband_utilities[i] = husband_utility  # Update husband's utilities

# Calculate descriptive statistics
results_df = pd.DataFrame({
    'Husband Contribution': husband_contributions,
    'Wife Utility': wife_utilities,
    'Husband Utility': husband_utilities  # Include husband's utility in results
})

descriptive_stats = results_df.describe()
print(descriptive_stats)
```

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