Rethinking Altruism in Economic Science: A Simulation-Based Study on Wealth Distribution

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ABSTRACT

This study explores the role of altruism in shaping wealth distribution within simulated economic environments, challenging prevailing assumptions in mainstream economic theory. Motivated by my experiences as an underpaid public defense attorney in Oregon, I sought to examine whether altruistic behaviors—particularly those that sacrifice self-interest—could have measurable impacts on economic inequality. Using a custom simulation model, we tested the effects of three types of altruism (**FAKE**, **SEMI**, and **PURE**) under various environmental conditions: Extreme Abundance, Normal, Scarcity, and Extreme Scarcity. Contrary to my initial hypothesis that greater altruism would exacerbate wealth disparity, the results show that environments with higher proportions of altruistic behaviors, particularly PURE altruism, lead to more equitable wealth distribution, even under conditions of scarcity. These findings suggest that altruism may play an underappreciated role in mitigating wealth inequality, highlighting a potential gap in traditional economic models that often dismiss altruistic behavior as economically unsustainable. The results encourage further research into the real-world impact of altruism in economic systems, and they raise important questions about the overlooked cultural and biological dimensions of inclusive fitness, altruism in professions like law, and the broader role of social cooperation in wealth creation.

I. INTRODUCTION

In my research, I was inspired to investigate the effects of altruism within economic systems, drawing on my experience as a public defense attorney during a severe public defense shortage in Oregon. This personal background has fueled my interest in understanding how altruism, defined as acting against one's own economic interests, plays a role in economic outcomes. As someone working under constant financial strain, the connection between altruistic behavior and economic impact became a compelling subject of exploration.

The U.S. public defense system is under immense strain due to a shortage of attorneys and overwhelming caseloads, which exacerbates inequality in access to justice, particularly for marginalized populations. My work in this environment reflects the sacrifices made by those who continue to practice public defense despite lower pay and high emotional and physical demands. The idea of altruism in lawyering, especially the willingness to sacrifice financial gain for the public good, resonates with the economic model of altruism explored in "Is Altruism Possible in Lawyering?"[1] This study emphasized how public defense attorneys often prioritize the well-being of their clients over their own financial security, a decision that mirrors the broader economic concept of altruism.

Inspired by these dynamics, I set out to examine how altruism, under varying conditions, might impact wealth distribution. I began this research with the hypothesis that environments rich in altruistic behavior could lead to increased wealth disparity. This hypothesis stemmed from traditional economic models that emphasize individual utility maximization and profit-seeking behaviors, as well as the notion that altruism could be unsustainable because it might concentrate wealth among non-altruistic

1 Carrie Menkel-Meadow, "Is Altruism Possible in Lawyering," *Ga. St. UL Rev.* 8 (1992): 385.

individuals. These models are exemplified in works like "Toward a Theory of Property Rights", which argues that property rights and economic systems traditionally focus on individuals maximizing their benefits.[2]

However, after conducting simulations and running experiments, the results indicated that altruism might, in fact, have the opposite effect, contributing to more equitable wealth distribution in certain environments (even when altruism represents a small minority of actors). These new findings challenge the initial hypothesis, shedding light on altruism's underestimated role in economics. The uncertainty in these outcomes is reminiscent of concepts outlined in "Uncertainty, Evolution, and Economic Theory", where economic behaviors are explained as adaptive mechanisms in uncertain environments.[3] In this case, altruism emerges as a vital component of economic adaptation, one that may not fit neatly into the classical framework of profit maximization but is still crucial for achieving positive outcomes in the face of uncertainty.

Through this research, I argue that altruism's role in economic behavior has been vastly underexplored, particularly in mainstream economic science. While theories such as the tragedy of the commons emphasize the destructive consequences of overusing shared resources, they often fail to account for the mitigating effects of altruistic behaviors, which can lead to cooperative solutions.[4] By experimenting with different proportions of altruism, this study contributes to a growing body of research that challenges the idea that self-interest alone drives successful economic systems. As seen in historical cases of extreme altruism, such as the actions of kamikaze pilots during World War II, altruism can lead to profound societal impacts, and its economic significance should not be underestimated.[5, 6]

To better understand these effects, further experimental data collection in real-world settings is needed. This will allow researchers to measure the long-term impacts of altruism on wealth distribution and inequality more comprehensively. This study's findings open new avenues for research, suggesting that altruism might be not just a philosophical ideal but a powerful economic force capable of reshaping systems that have long been assumed to rely solely on self-interest.

II. METHODS

The Altruism Model and Payout Matrix

In our study, we modeled altruism through a set of three distinct behavioral categories: **PURE**, **SEMI**, and **FAKE** altruism. Each of these categories reflects a different level of self-interest versus sacrifice in economic exchanges, and their impact on wealth distribution is dictated by the payout matrix we developed.

2 Chennat Gopalakrishnan, ed., *Classic Papers in Natural Resource Economics* (London: Palgrave Macmillan UK, 2000), https://doi.org/10.1057/9780230523210.

3 Armen A. Alchian, “Uncertainty, Evolution, and Economic Theory,” *Journal of Political Economy* 58, no. 3 (June 1950): 211–21, https://doi.org/10.1086/256940.

4 Alchian.

5 John Orbell and Tomonori Morikawa, “An Evolutionary Account of Suicide Attacks: The Kamikaze Case,” *Political Psychology* 32, no. 2 (April 2011): 297–322, https://doi.org/10.1111/j.1467-9221.2010.00808.x.

6 Hector N. Qirko, “ALTRUISM IN SUICIDE TERROR ORGANIZATIONS,” *Zygon*® 44, no. 2 (June 2009): 289–322, https://doi.org/10.1111/j.1467-9744.2009.01001.x.

1. **PURE Altruism** represents genuine sacrifice without any expectation of return. In this model, PURE altruists consistently give away wealth without benefiting themselves. These participants reduce their own wealth to benefit their partner, regardless of the partner's behavior. This could represent extreme altruistic actions, such as donating resources even when it harms the donor's own economic standing.
2. **SEMI Altruism** reflects a conditional form of altruism where individuals are willing to sacrifice some of their wealth, but only if their partner also reciprocates in some way. It represents a middle ground between PURE altruism and typical economic transactions. SEMI altruists may give away wealth but expect a modest return in exchange for their actions, leading to less extreme sacrifice than PURE altruism.
3. **FAKE Altruism** is not altruism in the traditional sense but serves as a stand-in for normal economic transactions where both parties expect mutual enrichment. In FAKE altruism, participants engage in exchanges that benefit both parties, mimicking transactions in which self-interest drives wealth accumulation. FAKE altruism therefore operates more like typical economic exchanges, where participants maximize mutual gain without any net sacrifice.

Payout Matrix

The following payout matrix outlines the changes in wealth for a pair of agents based on their altruistic behaviors during interactions:

Altruism Type 1	Altruism Type 2	Wealth Change for Agent 1	Wealth Change for Agent 2
FAKE	FAKE	+10	+10
FAKE	SEMI	-10	+20
FAKE	PURE	+20	-50
SEMI	FAKE	+20	-10
SEMI	SEMI	+50	+50
SEMI	PURE	-5	-50
PURE	FAKE	-50	+20
PURE	SEMI	-50	+5
PURE	PURE	-50	-50

This matrix shows that PURE altruists always lose wealth in pairings, often significantly, whereas FAKE altruists tend to benefit from every interaction. The nature of each pairing creates a diverse range of wealth redistribution, helping us assess the sustainability of altruism over time.

Nash Equilibrium and Expected Outcomes

To analyze the expected outcomes, we considered a scenario where all agents act rationally to maximize their utility. In our model, however, agents classified as PURE altruists violate the classic

Nash equilibrium principle because they do not seek to maximize their own wealth but instead prioritize the benefit of others.

Under a traditional Nash equilibrium, FAKE altruists would dominate the system because they always expect a positive return from interactions. PURE and SEMI altruists would gradually lose wealth, pushing the system toward increasing disparity, as the wealth of PURE altruists erodes while FAKE altruists accumulate wealth. This assumption aligns with classical economic theory, where altruism is considered unsustainable.

Mathematically, given the payout matrix, the Nash equilibrium would favor a strategy where agents act as FAKE altruists in all interactions to ensure consistent positive wealth accumulation. However, our simulation results, as outlined in the Discussion section, challenge this expectation by showing that wealth distribution remained relatively balanced, even in environments with high levels of PURE and SEMI altruism.

Environmental Scenarios and Altruism Proportions

In our experiment, we tested four different environmental scenarios representing varying levels of resource availability and economic prosperity. Each environment had a distinct set of proportions for FAKE, SEMI, and PURE altruism, as determined by a random number generation process in our COBOL simulation model. The probabilities were as follows:

- Extreme Abundance (Environment 1):
  - FAKE: 70%
  - SEMI: 20%
  - PURE: 10%
- Normal Abundance (Environment 2):
  - FAKE: 60%
  - SEMI: 20%
  - PURE: 20%
- Scarcity (Environment 3):
  - FAKE: 70%
  - SEMI: 20%
  - PURE: 10%
- Extreme Scarcity (Environment 4):
  - FAKE: 60%
  - SEMI: 10%
  - PURE: 30%

Note that Environment 1 and 3, being identical in our program, are reported in the results as just Environment 1.

These proportions were selected to reflect *traditional* economic assumptions, where FAKE altruism—self-interest—dominates in most environments. However, the unexpectedly large significance of even minor amounts of PURE altruism in all environments, including Extreme Scarcity, suggests that altruistic behavior may play a more significant role in economic systems than previously thought. The proportions also reflect the assumption that in extreme scarcity, such as during the waning days of

World War II in Japan, PURE altruism modestly increases as people become more generous when they have nothing else to lose.

In summary, the methods we employed, including the payout matrix and the assignment of altruism types based on environmental scenarios, were designed to test the long-term sustainability of altruism in different economic conditions. The COBOL simulation (*source code provided at the end of this article*) provided a dynamic framework for understanding how varying levels of altruism impact wealth distribution, challenging the assumption that altruism leads to unsustainable economic outcomes. By stacking the deck against PURE altruism, we aimed to explore whether the impact of altruism truly fades away in harsh economic conditions. However, the results of our experiment, as previewed in the Introduction and explored further in the Results section, cast serious doubt on this assumption.

III. RESULTS

To predict how altruism manifests in real-world economic interactions, we model three types of altruistic behavior: fake altruism, semi-altruism, and pure altruism. We use a payoff matrix to represent the outcomes of various interactions between individuals exhibiting these behaviors, and we analyze the resulting Nash Equilibria.

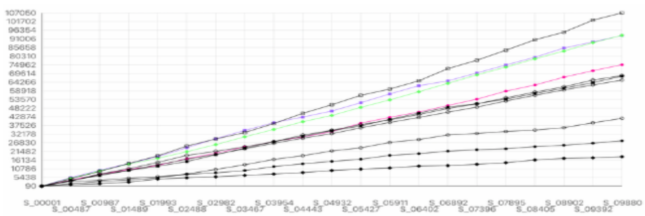
- Extreme Abundance: In this environment, wealth disparity seems to increase steadily over time. The wealth of the top agents accelerates sharply, indicating a tendency for the wealthy to accumulate significantly more over time. Agents with less wealth experience much slower growth, creating a notable divergence in wealth distribution. (Figures 1, 2, 3, 4, & 5).
- Normal Abundance: In the Normal environment, the distribution of wealth remains relatively more balanced, though it still exhibits some divergence over time. Wealthier agents accumulate more, but not to the same extreme as in the Abundance model. The middle-tier agents experience moderate wealth growth, while the lowest-tier agents' growth stagnates. (Figures 6, 7, 8, 9 & 10).
- Extreme Scarcity: Interestingly, in the Extreme Scarcity environment, wealth inequality appears less pronounced compared to Extreme Abundance. While wealthier agents still grow faster, the overall distribution is more compact. (Figures 11, 12, 13, 14, & 15).

Observations

- Wealth Growth: In all environments, the agents at the higher end of the distribution (those who became wealthy early) tend to pull further ahead over time, especially in Extreme Abundance.
- Wealth Concentration: Extreme Abundance shows the most significant concentration of wealth among the top agents.
- Role of Altruism: The initial hypothesis that PURE altruism would exacerbate wealth inequality does not hold based on the data. Instead, altruism, particularly PURE altruism, in Extreme Scarcity may mitigate the effects of wealth disparity.

The data sets, when averaged, show significant trends that we will explore further in the analysis section. These observations challenge prevailing economic assumptions about altruism's role in increasing inequality.

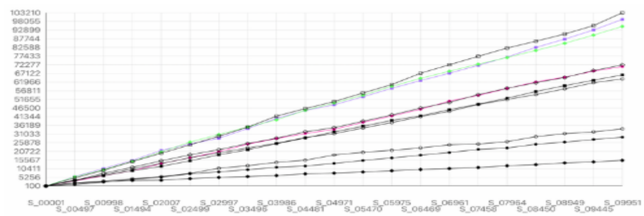
Figure 1: Extreme Abundance Round 1 w/10,000 transactions



***x* = step number *y* = wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

Figure 2: Extreme Abundance Round 2 w/10,000 transactions



***x* = step number *y* = wealth units**

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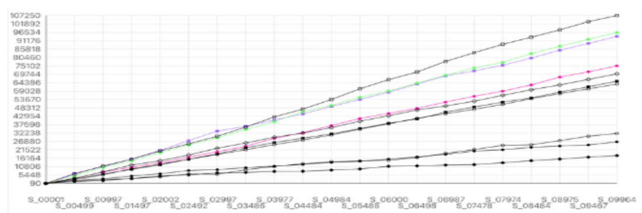
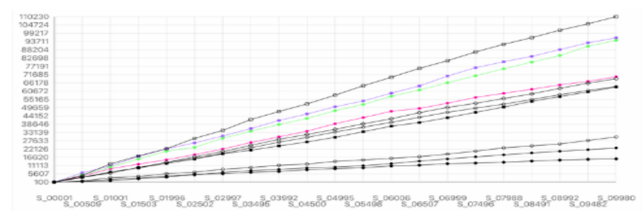
Figure 3: Extreme Abundance Round 3 w/10,000 transactions



***x* = step number *y* = wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

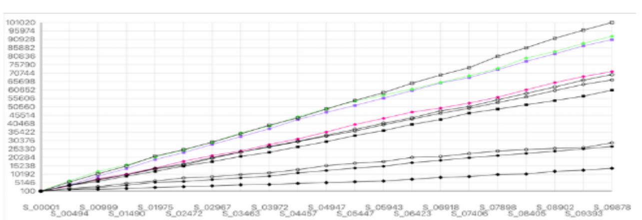
Figure 4: Extreme Abundance Round 4 w/10,000 transactions



***x* = step number *y* = wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

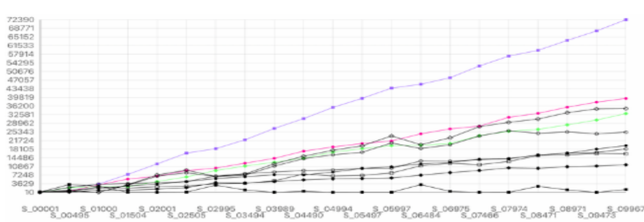
Figure 5: Extreme Abundance Round 5 w/10,000 transactions



***x* = step number *y* = wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

Figure 6: Normal Abundance Round 1 w/10,000 transactions



***x* = step number *y* = wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

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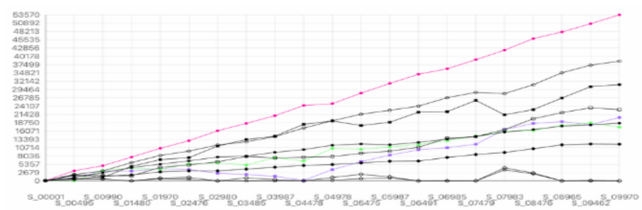
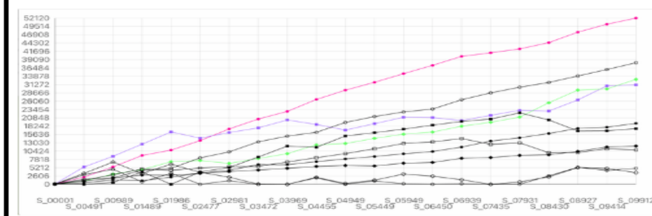
Figure 7: Normal Abundance Round 2 w/10,000 transactions



x **= step number** ***y*** **= wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

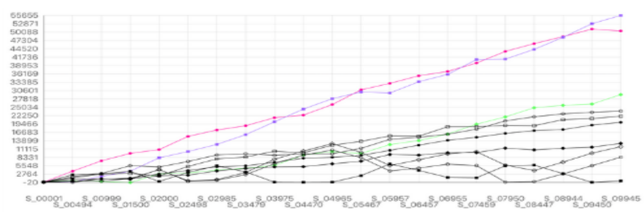
Figure 8: Normal Abundance Round 3 w/10,000 transactions



x **= step number** ***y*** **= wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

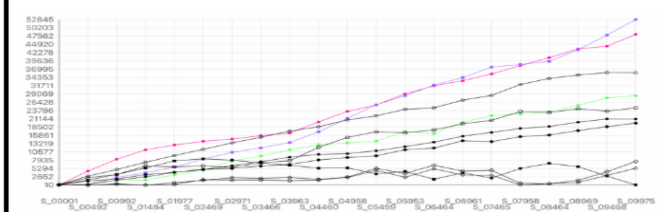
Figure 9: Normal Abundance Round 4 w/10,000 transactions



x **= step number** ***y*** **= wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

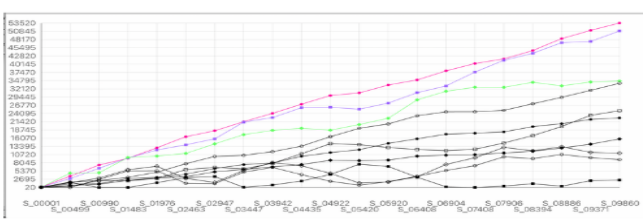
Figure 10: Normal Abundance Round 5 w/10,000 transactions



x **= step number** ***y*** **= wealth units**

Every line represents a unique economic agent (i.e.: individual person or group in our model economy). The step number which is sampled approximately every 500 steps (i.e. discrete transactions). For technical reasons, the sampling is spaced only approximately every 500 steps (not exactly 500 steps) because the volume of text between two data points varied due to the way the program reported the data based on the pairings of each agent.

Figure 11: Extreme Scarcity Round 1 w/10,000 transactions



x **= step number** ***y*** **= wealth units**

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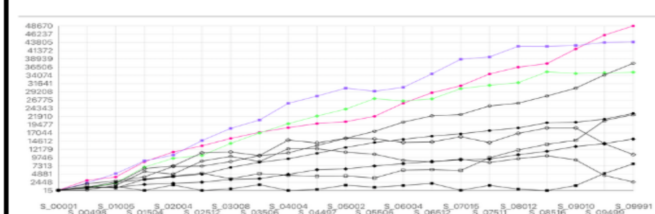
Figure 12: Extreme Scarcity Round 2 w/10,000 transactions



x **= step number** ***y*** **= wealth units**

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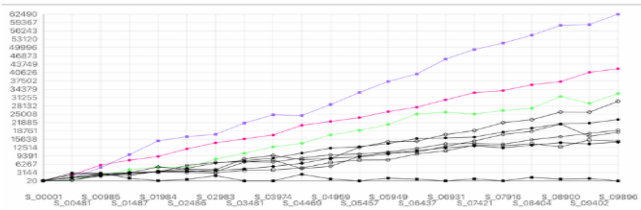
Figure 13: Extreme Scarcity Round 3 w/10,000 transactions



***x* = step number *y* = wealth units**

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Figure 14: Extreme Scarcity Round 4 w/10,000 transactions

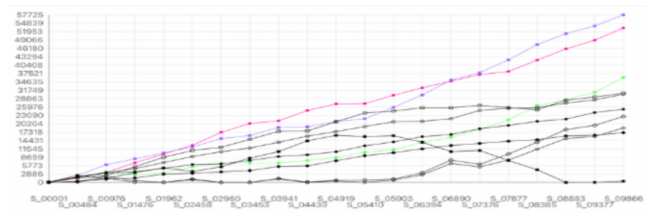

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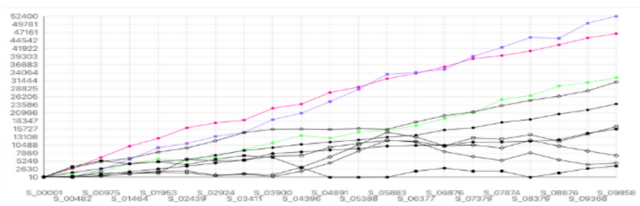
Figure 15: Extreme Scarcity Round 5 w/10,000 transactions



***x* = step number *y* = wealth units**

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IV. ANALYSIS

Our experiment sought to investigate how varying proportions of altruistic behavior—FAKE, SEMI, and PURE—affect wealth distribution across different environmental settings. The environments, representing Extreme Abundance, Normal, and Extreme Scarcity, correspond to different levels of resource availability and influenced the types of altruism participants exhibited. The proportions of these altruistic behaviors were controlled by the environment, as seen in our simulation model. Through our simulation, we measured wealth disparity using metrics such as the Gini coefficient, standard deviation, and the coefficient of variation (CV) at multiple intervals over 10,000 steps.

Wealth Variance by Environment:

The wealth variance analysis provides critical insight into how different environments foster wealth inequality:

1. **Extreme Abundance**: Average Gini Coefficient: 0.1 → 0.038; Wealth Variance: 321.7 million; Coefficient of Variation (CV): 0.2 → 0.076. In the Extreme Abundance environment, wealth inequality initially started high, with the Gini coefficient around 0.1 but decreased to 0.038 over time. Despite this reduction in inequality, wealth variance was the highest at 321.7 million, suggesting that the wealthiest agents accumulated significantly more wealth than others. FAKE altruism, which mimics standard economic transactions, dominated, leading to a substantial accumulation of wealth by those already advantaged. The wealth disparity persisted despite a decline in the Gini coefficient, pointing to significant overall differences in wealth accumulation rates.
2. **Normal Abundance**: Average Gini Coefficient: 0.04 → 0.05; Wealth Variance: 97.2 million; Coefficient of Variation (CV): 0.08 → 0.1. In the Normal environment, wealth distribution remained fairly stable over time. The Gini coefficient showed slight fluctuations, from 0.04 to 0.05, indicating consistent, moderate levels of wealth inequality. The wealth variance was lower than in Extreme Abundance, at 97.2 million, and the coefficient of variation increased slightly, suggesting that while some agents continued to gain more wealth than others, the disparity was not as pronounced. The balance between FAKE, SEMI, and PURE altruism in this environment helped stabilize wealth distribution to a degree.
3. **Extreme Scarcity**: Average Gini Coefficient: 0.038 → 0.018; Wealth Variance: 96.5 million; Coefficient of Variation (CV): 0.076 → 0.03. Extreme Scarcity, **contrary** to our hypothesis, produced the lowest levels of wealth disparity. The Gini coefficient started at 0.038 and dropped to a low of 0.018 over time, indicating a significant reduction in inequality. The wealth variance was also the lowest, at 96.5 million, similar to that in the Normal environment. The coefficient of variation dropped sharply from 0.076 to 0.03, showing that wealth became more evenly distributed among agents in this environment. PURE altruism was most common in this setting, helping to redistribute wealth more equally, even though the overall wealth levels were lower due to scarcity.

Further Observations

- **Extreme Abundance** exhibited the highest wealth inequality, with significant wealth accumulation by wealthier agents, driven largely by FAKE altruism. Although the Gini coefficient decreased over time, the wealth disparity persisted, as reflected in the large variance.
- **Normal Abundance** presented moderate wealth inequality, with stable Gini coefficients and wealth variance. This balance of altruistic behaviors led to more consistent wealth distribution.
- **Extreme Scarcity**, unexpectedly, led to the lowest wealth inequality, though absolute wealth levels were lower. The drop in Gini coefficient and coefficient of variation highlights how scarcity can act as an equalizing force when altruistic behavior is prevalent.

These findings challenge traditional economic models, which often dismiss the role of altruism, particularly PURE altruism, in reducing wealth inequality. Our experiment suggests that altruism, even under conditions of extreme scarcity, can play a crucial role in equalizing wealth distribution. This has significant implications for economic theory and policymaking, where altruism could be leveraged to address wealth disparity in both abundant and scarce environments.

V. DISCUSSION

Traditional economic science often focuses on rational, self-interested behaviors, with altruism seen as an outlier that plays a minor role in wealth distribution. Our experiment, however, demonstrates that environments with a greater presence of altruism—defined as PURE and SEMI in our model—lead to more equitable wealth distribution, contrary to what prevailing models might predict. Even environments with extreme scarcity, where resources are limited, showed less wealth inequality when altruism was present. The data from our analysis, particularly the Gini coefficient and variance results, provide evidence that altruistic behavior can stabilize wealth distribution.

This finding aligns with theories of inclusive fitness in biological science, where individuals act in ways that benefit others, often at a cost to themselves, to ensure the survival of the larger group or kin. Studies of altruism in evolutionary biology, such as those cited in **"An Evolutionary Account of Suicide Attacks: The Kamikaze Case"** and **"Altruism in Suicide Terror Organizations"**, show that self-sacrificial behaviors are not necessarily irrational but are part of survival strategies in resource-scarce environments.[7, 8] Our research indicates that economic models should incorporate this understanding, as altruism can lead to more equitable resource distribution.

The Legal Profession and Public Defense

My personal background as a public defense attorney in Oregon, where the public defense system is currently facing a crisis due to chronic underfunding and overwhelming caseloads,[9] inspired this study on altruism. Public defenders often act out of a sense of altruism, representing indigent clients even when compensation is inadequate. The legal profession thus offers a real-world example of how altruism operates under conditions of scarcity. Despite financial hardships, public defenders continue to perform their duties because of a commitment to social justice, akin to what we observed in our simulations of PURE and SEMI altruism.

This observation draws on research in "Is Altruism Possible in Lawyering?", which argues that altruistic lawyering is a critical component of ensuring access to justice.[10] In the context of the Oregon public defense crisis, it is clear that lawyers are willing to sacrifice personal economic gain for the public good.[11] This underscores the need to reconsider the role of altruism not just in theoretical economic models but in professions where the welfare of others takes precedence over self-interest.

Culture and Economic Behavior

Our study also sheds light on the often-overlooked role of culture in economic behavior. According to Geert Hofstede's work on national cultures, cultural dimensions such as individualism versus

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7 Orbell and Morikawa, “An Evolutionary Account of Suicide Attacks.”
8 Qirko, “ALTRUISM IN SUICIDE TERROR ORGANIZATIONS.”
9 Molly Pettit, “Understanding the Crisis: The Evolution of Indigent Defense in Oregon,” 2023, https://pdxscholar.library.pdx.edu/honorstheses/1404/.
10 Menkel-Meadow, “Is Altruism Possible in Lawyering.”
11 Pettit, “Understanding the Crisis.”

collectivism can have profound impacts on how organizations and individuals behave economically.[12] Cultures that value collectivism may promote altruistic behaviors more readily than individualistic cultures, where personal wealth accumulation is prioritized. Our results suggest that future research should investigate how cultural factors might promote altruistic behaviors in different contexts.

The Role of the Commons

Finally, our findings relate to Garret Hardin's seminal work, "The Tragedy of the Commons", which warns of the depletion of shared resources due to individual self-interest.[13] In contrast, our study shows that altruistic behaviors can help mitigate the "tragedy" by promoting more equitable distribution of resources. By incorporating altruism into the economic management of common resources, societies may prevent the depletion of resources and avoid wealth disparity.

VI. CONCLUSION

Our research challenges the notion that altruism plays a negligible role in economic science. Instead, altruism, particularly PURE and SEMI forms, can significantly impact wealth distribution *even when only a minority of agents participate in altruism*, promoting equity even in resource-scarce environments. This finding suggests a need for further real-world experimentation and incorporation of altruism into mainstream economic models. Additionally, the study’s implications for the legal profession and cross-cultural economic behaviors highlight the multifaceted nature of altruism in human society. Economic models must evolve to recognize the role of altruistic behavior in shaping equitable wealth distribution, particularly as societies face growing resource challenges.

COBOL Source Code for the Modeling Program after Citations on the following pages.

12 Geert Hofstede, “National Cultures in Four Dimensions: A Research-Based Theory of Cultural Differences among Nations,” *International Studies of Management & Organization* 13, no. 1–2 (March 1983): 46–74, https://doi.org/10.1080/00208825.1983.11656358.

13 Garrett Hardin, “The Tragedy of the Commons: The Population Problem Has No Technical Solution; It Requires a Fundamental Extension in Morality.,” *Science* 162, no. 3859 (December 13, 1968): 1243–48, https://doi.org/10.1126/science.162.3859.1243.

CITATIONS

Alchian, Armen A. "Uncertainty, Evolution, and Economic Theory." *Journal of Political Economy* 58, no. 3 (June 1950): 211–21. https://doi.org/10.1086/256940.

Gopalakrishnan, Chennat, ed. *Classic Papers in Natural Resource Economics*. London: Palgrave Macmillan UK, 2000. https://doi.org/10.1057/9780230523210.

Hardin, Garrett. "The Tragedy of the Commons: The Population Problem Has No Technical Solution; It Requires a Fundamental Extension in Morality." *Science* 162, no. 3859 (December 13, 1968): 1243–48. https://doi.org/10.1126/science.162.3859.1243.

Hofstede, Geert. "National Cultures in Four Dimensions: A Research-Based Theory of Cultural Differences among Nations." *International Studies of Management & Organization* 13, no. 1–2 (March 1983): 46–74. https://doi.org/10.1080/00208825.1983.11656358.

Menkel-Meadow, Carrie. "Is Altruism Possible in Lawyering." *Ga. St. UL Rev.* 8 (1992): 385.

Orbell, John, and Tomonori Morikawa. "An Evolutionary Account of Suicide Attacks: The Kamikaze Case." *Political Psychology* 32, no. 2 (April 2011): 297–322. https://doi.org/10.1111/j.1467-9221.2010.00808.x.

Pettit, Molly. "Understanding the Crisis: The Evolution of Indigent Defense in Oregon," 2023. https://pdxscholar.library.pdx.edu/honorstheses/1404/.

Qirko, Hector N. "ALTRUISM IN SUICIDE TERROR ORGANIZATIONS." *Zygon®* 44, no. 2 (June 2009): 289–322. https://doi.org/10.1111/j.1467-9744.2009.01001.x.

Source code to program on the following pages →

SOURCE CODE FOR COBOL PROGRAM

Note: COBOL is an old programing language developed in the 1960s at a time when programs were punched onto paper cards; the red lines in the code are not glitches but reflect the proper formating of COBOL syntax, which is a legacy of the punch-card era.

Read the code left to right following the numbered lines, ie:

1	3
2	4
5	7
6	8

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```
      ******************************************************************
      * Author: WESTON KOYAMA
      * Date: SEPTEMBER 15, 2024
      * Purpose: ECONOMIC SCIENCE RESEARCH
      * Tectonics: cobc
      ******************************************************************
       IDENTIFICATION DIVISION.
       PROGRAM-ID. AltruismGameTheorySim.

       DATA DIVISION.
       WORKING-STORAGE SECTION.
       01 NMAGENTS        PIC 9(3) VALUE 10.
       01 NMSTPS          PIC 9(5) VALUE 1000.
       01 STPCNT          PIC 9(5).
       01 TOTAL-STEPS     PIC 9(5) VALUE 0.
       01 TEMP-ID         PIC 9(3).
       01 AGTID           PIC 9(3).
       01 TEMPWLTH        PIC 9(6).
       01 ENVLVL          PIC 9(1) VALUE 1.
       01 RANDOM-VAL      PIC 9(5).
       01 SEED-VALUE      PIC 9(9).
       01 WS-DATE         PIC 9(8).
       01 WS-TIME         PIC 9(6).
       01 WS-MINUTE       PIC 9(2).
       01 MULTIPLIER      PIC 9(10) VALUE 1103515245.
       01 INCREMENT       PIC 9(9) VALUE 12345.
       01 MODULUS         PIC 9(10) VALUE 32768.
       01 AGENT-WLTH OCCURS 10 TIMES PIC S9(6) VALUE 100.
       01 AGENT-ALTTYPE OCCURS 10 TIMES PIC X(10) VALUE SPACES.
       01 AGENT-PAIRED OCCURS 10 TIMES PIC X(1) VALUE 'N'.  *> Tracks if agents ar
       01 SHUFFLED-INDEX OCCURS 10 TIMES PIC 9(3) VALUE ZEROS.
       01 USER-RESPONSE  PIC X(1) VALUE SPACE.

       PROCEDURE DIVISION.
       MAINLOGIC SECTION.
           DISPLAY "Choose Level (1 = Extreme Abundance, 2 = Normal , " -
           "3 = Scarcity, 4 = Extreme Scarcity): ".
           ACCEPT ENVLVL.
           ACCEPT WS-DATE FROM DATE.
           ACCEPT WS-TIME FROM TIME.
           MOVE WS-DATE TO SEED-VALUE.
           ADD WS-TIME TO SEED-VALUE.

           MOVE 1 TO STPCNT  *> Initialize STPCNT to 1.

           *> Initialize SHUFFLED-INDEX and AGENT-PAIRED arrays to avoid uninitial
           PERFORM VARYING AGTID FROM 1 BY 1 UNTIL AGTID > NMAGENTS
               MOVE 0 TO SHUFFLED-INDEX(AGTID)
               MOVE 'N' TO AGENT-PAIRED(AGTID)
           END-PERFORM.

           *> Start with USER-RESPONSE as 'Y' to enter the loop.
           PERFORM UNTIL USER-RESPONSE = "N"
               PERFORM VARYING STPCNT FROM STPCNT BY 1
                   UNTIL STPCNT > TOTAL-STEPS + NMSTPS
                       PERFORM SHUFFLE-PAIRINGS  *> Shuffle pairings each step.
                       PERFORM SIMULATEENV  *> Run simulation for each step.
                       PERFORM DISPLAYWEALTH  *> Display wealth after each step.
               END-PERFORM
               ADD NMSTPS TO TOTAL-STEPS
               DISPLAY "Simulation has completed " TOTAL-STEPS " steps."
               DISPLAY "Continue for another " NMSTPS " steps? (Y/N): "
               ACCEPT USER-RESPONSE
               PERFORM UNTIL USER-RESPONSE = "Y" OR USER-RESPONSE = "N"
                   DISPLAY "Invalid input. Please enter Y or N: "
                   ACCEPT USER-RESPONSE
               END-PERFORM
               IF USER-RESPONSE = "Y" THEN
                   MOVE TOTAL-STEPS TO STPCNT
               END-IF
           END-PERFORM.

```

Source code continues on following page →

```
    STOP RUN.

SHUFFLE-PAIRINGS SECTION.
    *> Shuffle agent indices using Fisher-Yates shuffle to ensure pairing.
    PERFORM VARYING AGTID FROM 1 BY 1 UNTIL AGTID > NMAGENTS
        PERFORM GENERATE-RANDOM  *> Use custom random number generator.
        DIVIDE RANDOM-VAL BY NMAGENTS GIVING TEMP-ID
            REMAINDER SHUFFLED-INDEX(AGTID)
        ADD 1 TO SHUFFLED-INDEX(AGTID)
    END-PERFORM.

    *> Ensure no agent is paired with itself and shuffle again if necessary.
    PERFORM VARYING AGTID FROM 1 BY 1 UNTIL AGTID > NMAGENTS
        IF SHUFFLED-INDEX(AGTID) = AGTID THEN
            IF AGTID < NMAGENTS THEN
                MOVE SHUFFLED-INDEX(AGTID + 1) TO TEMP-ID
                MOVE TEMP-ID TO SHUFFLED-INDEX(AGTID)
            ELSE
                MOVE SHUFFLED-INDEX(1) TO TEMP-ID
                MOVE TEMP-ID TO SHUFFLED-INDEX(AGTID)
            END-IF
        END-IF
    END-PERFORM.

    *> Validation Step: Ensure every agent is paired.
    PERFORM VARYING AGTID FROM 1 BY 1 UNTIL AGTID > NMAGENTS
        IF SHUFFLED-INDEX(AGTID) = 0 THEN
            DISPLAY "Error: Agent " AGTID " not paired."
            DIVIDE AGTID BY NMAGENTS
                GIVING TEMP-ID
                REMAINDER TEMP-ID
            ADD 1 TO TEMP-ID
            MOVE SHUFFLED-INDEX(TEMP-ID) TO SHUFFLED-INDEX(AGTID)
        END-IF
    END-PERFORM.
    EXIT.

SIMULATEENV SECTION.
    DISPLAY "STARTING SIMULATION FOR STEP: " STPCNT.
    *> Reassign altruism types each step based on environment level.
    PERFORM VARYING AGTID FROM 1 BY 1 UNTIL AGTID > NMAGENTS
        MOVE 'N' TO AGENT-PAIRED(AGTID)  *> Reset paired status for each st
        PERFORM GENERATE-RANDOM  *> Generate random value for each agent.
        DISPLAY "Reassigning altruism for Agent " AGTID
        EVALUATE ENVLVL
            WHEN 1 *> Extreme Abundance
                IF RANDOM-VAL <= 7 THEN
                    MOVE 'FAKE' TO AGENT-ALTTYPE(AGTID)
                ELSE
                    IF RANDOM-VAL <= 9 THEN
                        MOVE 'SEMI' TO AGENT-ALTTYPE(AGTID)
                    ELSE
                        MOVE 'PURE' TO AGENT-ALTTYPE(AGTID)
                    END-IF
                END-IF
            WHEN 2 *> Normal
                IF RANDOM-VAL <= 6 THEN
                    MOVE 'FAKE' TO AGENT-ALTTYPE(AGTID)
                ELSE
                    IF RANDOM-VAL <= 8 THEN
                        MOVE 'SEMI' TO AGENT-ALTTYPE(AGTID)
                    ELSE
                        MOVE 'PURE' TO AGENT-ALTTYPE(AGTID)
                    END-IF
                END-IF
            WHEN 3 *> Scarcity
                IF RANDOM-VAL <= 7 THEN
                    MOVE 'FAKE' TO AGENT-ALTTYPE(AGTID)
                ELSE
                    IF RANDOM-VAL <= 9 THEN
                        MOVE 'SEMI' TO AGENT-ALTTYPE(AGTID)
                    ELSE
                        MOVE 'PURE' TO AGENT-ALTTYPE(AGTID)
                    END-IF
                END-IF
            WHEN 4 *> Extreme Scarcity
                IF RANDOM-VAL <= 6 THEN
                    MOVE 'FAKE' TO AGENT-ALTTYPE(AGTID)
                ELSE
                    IF RANDOM-VAL <= 8 THEN
                        MOVE 'SEMI' TO AGENT-ALTTYPE(AGTID)
                    ELSE
                        MOVE 'PURE' TO AGENT-ALTTYPE(AGTID)
                    END-IF
                END-IF
        END-EVALUATE
        DISPLAY "Agent " AGTID " Altruism Type: "
        DISPLAY AGENT-ALTTYPE(AGTID)
    END-PERFORM.


*> After assigning altruism types, pair agents and calculate wealth.
PERFORM VARYING AGTID FROM 1 BY 1 UNTIL AGTID > NMAGENTS
    IF AGENT-PAIRED(AGTID) = 'N' THEN  *> Only process agents not yet paire
        MOVE SHUFFLED-INDEX(AGTID) TO TEMP-ID  *> Use shuffled pairings.

        *> Add a check for TEMP-ID to ensure it is valid and not yet paired
        IF TEMP-ID >= 1 AND TEMP-ID <= NMAGENTS THEN
            IF AGENT-PAIRED(TEMP-ID) = 'N' THEN
                PERFORM PAIR-DECISION
                DISPLAY "Agent " AGTID " paired w Agent " TEMP-ID
                DISPLAY "Agent " AGTID " Alt Type: "
                DISPLAY AGENT-ALTTYPE(AGTID)
                DISPLAY "Agent " TEMP-ID " Alt Type: "
                DISPLAY AGENT-ALTTYPE(TEMP-ID)
                PERFORM PAIR-AGENTS
                MOVE 'Y' TO AGENT-PAIRED(AGTID)
                MOVE 'Y' TO AGENT-PAIRED(TEMP-ID)
            END-IF
        END-IF
    END-IF
END-PERFORM
DISPLAY "END OF STEP " STPCNT
EXIT.



PAIR-DECISION SECTION.
    EVALUATE ENVLVL
        WHEN 1 *> Extreme Abundance.
            IF AGENT-ALTTYPE(AGTID) = 'FAKE'
               AND AGENT-ALTTYPE(TEMP-ID) = 'FAKE' THEN
                DISPLAY "Both agents are FAKE w Extrm Abundance."
            ELSE IF AGENT-ALTTYPE(AGTID) = 'SEMI'
                    AND AGENT-ALTTYPE(TEMP-ID) = 'SEMI' THEN
                DISPLAY "Both agents are SEMI w Extrm Abundance."
            ELSE IF AGENT-ALTTYPE(AGTID) = 'PURE'
                    AND AGENT-ALTTYPE(TEMP-ID) = 'PURE' THEN
                DISPLAY "Both agents are PURE w Extrm Abundance."
            ELSE
                DISPLAY "Mixed pairing in Extreme Abundance."
            END-IF
    END-EVALUATE.
    EXIT.

PAIR-AGENTS SECTION.
    IF AGTID >= 1 AND AGTID <= NMAGENTS AND
       TEMP-ID >= 1 AND TEMP-ID <= NMAGENTS THEN
        IF AGENT-ALTTYPE(AGTID) = 'FAKE'
           AND AGENT-ALTTYPE(TEMP-ID) = 'FAKE' THEN
            ADD 10 TO AGENT-WLTH(AGTID)
            ADD 10 TO AGENT-WLTH(TEMP-ID)
        ELSE IF AGENT-ALTTYPE(AGTID) = 'SEMI'
                AND AGENT-ALTTYPE(TEMP-ID) = 'SEMI' THEN
            ADD 50 TO AGENT-WLTH(AGTID)
            ADD 50 TO AGENT-WLTH(TEMP-ID)
        ELSE IF AGENT-ALTTYPE(AGTID) = 'SEMI'
                AND AGENT-ALTTYPE(TEMP-ID) = 'FAKE' THEN
            IF AGENT-WLTH(AGTID) >= 10 THEN
                ADD 20 TO AGENT-WLTH(TEMP-ID)
                SUBTRACT 10 FROM AGENT-WLTH(AGTID)
            ELSE
                DISPLAY "Agent " AGTID " no wealth to give!"
            END-IF
        ELSE IF AGENT-ALTTYPE(AGTID) = 'SEMI'
                AND AGENT-ALTTYPE(TEMP-ID) = 'PURE' THEN
            IF AGENT-WLTH(AGTID) >= 5
               AND AGENT-WLTH(TEMP-ID) >= 50 THEN
                SUBTRACT 5 FROM AGENT-WLTH(AGTID)
                SUBTRACT 50 FROM AGENT-WLTH(TEMP-ID)
            ELSE
                IF AGENT-WLTH(AGTID) < 5 THEN
                    DISPLAY "Agent " AGTID " no wealth to give!"
                END-IF
                IF AGENT-WLTH(TEMP-ID) < 50 THEN
                    DISPLAY "Agent " TEMP-ID " no wealth left!"
                END-IF
            END-IF
        ELSE IF AGENT-ALTTYPE(AGTID) = 'PURE'
                AND AGENT-ALTTYPE(TEMP-ID) = 'PURE' THEN
            IF AGENT-WLTH(AGTID) >= 50
               AND AGENT-WLTH(TEMP-ID) >= 50 THEN
                SUBTRACT 50 FROM AGENT-WLTH(AGTID)
                SUBTRACT 50 FROM AGENT-WLTH(TEMP-ID)
            ELSE
                IF AGENT-WLTH(AGTID) < 50 THEN
                    DISPLAY "Agent " AGTID " no wealth to give!"
                END-IF
                IF AGENT-WLTH(TEMP-ID) < 50 THEN
                    DISPLAY "Agent " TEMP-ID " no wealth left!"
                END-IF
            END-IF
        ELSE IF AGENT-ALTTYPE(AGTID) = 'FAKE'
                AND AGENT-ALTTYPE(TEMP-ID) = 'PURE' THEN
            IF AGENT-WLTH(TEMP-ID) >= 50 THEN
                ADD 20 TO AGENT-WLTH(AGTID)
                SUBTRACT 50 FROM AGENT-WLTH(TEMP-ID)
            ELSE
                DISPLAY "Agent " TEMP-ID " no wealth to give!"
            END-IF
        END-IF
    ELSE
        DISPLAY "Error: AGTID or TEMP-ID out of bounds."
    END-IF
    EXIT.

GENERATE-RANDOM SECTION.
    ACCEPT WS-TIME FROM TIME
    MOVE WS-TIME(5:2) TO WS-MINUTE
    ADD WS-MINUTE TO SEED-VALUE
    ADD AGTID TO SEED-VALUE  *> Ensure agent ID affects randomness.
    COMPUTE RANDOM-VAL = (SEED-VALUE * MULTIPLIER + INCREMENT)
    DIVIDE RANDOM-VAL BY MODULUS
        GIVING RANDOM-VAL
        REMAINDER RANDOM-VAL
    *> Ensure random value is in the range of 1 to 10.
    DIVIDE RANDOM-VAL BY 10
        GIVING RANDOM-VAL
        REMAINDER RANDOM-VAL
    IF RANDOM-VAL = 0 THEN
        MOVE 1 TO RANDOM-VAL
    END-IF
    EXIT.

DISPLAYWEALTH SECTION.
    DISPLAY "Wealth of Agents after Step: " STPCNT
```

Source code continues on following page →

```
           PERFORM VARYING AGTID FROM 1 BY 1 UNTIL AGTID > NMAGENTS
               DISPLAY "Agent " AGTID " Final Wealth: "
               DISPLAY AGENT-WLTH(AGTID)
           END-PERFORM
           EXIT.
```

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