Step 4: Section Summaries (English)

Title: Introduction to Cooperation, Fairness, and Altruistic Punishment
Short description: Explores the evolutionary origins of fairness and altruistic punishment in social cooperation.
Abstract:
This section introduces the central question of why humans cooperate, maintain moral attitudes, and punish unfairness even at a personal cost. It examines the conflict between these behaviors and traditional economic theories of self-interest. The authors propose an evolutionary utility framework that integrates expected utility models with evolutionary dynamics. By considering co-evolutionary interactions between culture, genes, and social norms, the study aims to explain how fairness and punishment emerge naturally. The approach builds upon past research in behavioral economics, psychology, and evolutionary biology, setting the foundation for the subsequent analysis.

Title: The Model - General Framework and Public Goods Game
Short description: Presents a theoretical model for cooperation and punishment using public goods games.
Abstract:
The model is based on evolutionary competition, where agents' fitness is linked to their cumulative payoff. Traits, including cooperative behavior and punishment tendencies, evolve over time under natural selection pressures. The public goods game with punishment is used as the framework to study these interactions. In this model, agents contribute resources to a collective pool and decide whether to punish defectors. The study introduces key variables such as punishment efficiency, contribution levels, and social norms. This section lays the mathematical foundation for understanding how cooperation and fairness preferences can evolve.

Title: Evolutionary Dynamics and Strategy Analysis
Short description: Analyzes how cooperation and punishment evolve in a population over time.
Abstract:
Using evolutionary game theory, the section identifies two possible long-term evolutionary states: defection or coordinated cooperation. If punishment is weak, defection dominates; if punishment is strong, cooperative norms stabilize. The model also explores how punishment itself emerges as a stable trait due to evolutionary pressures. Key findings highlight that other-regarding preferences, such as disadvantageous inequity aversion, can transform a social dilemma into a coordination problem. This dynamic results in a self-reinforcing feedback loop where cooperative behavior and punishment co-evolve to maintain fairness within populations.

Title: Empirical Validation of the Theory
Short description: Compares theoretical predictions with real-world experimental data.
Abstract:
The study tests its theoretical predictions against data from three independently conducted public goods game experiments. These experiments measure contributions, punishment behavior, and fairness preferences among participants. The results strongly align with the model’s predictions, showing that individuals tend to punish defectors at a rate proportional to the fairness norm. The observed punishment levels closely match the theoretical optimal punishment rate derived in the model. This empirical validation supports the hypothesis that fairness preferences and punishment behaviors are evolutionarily stable traits.

Title: Evolutionary Dominance of Other-Regarding Preferences
Short description: Demonstrates that fairness preferences outcompete selfish strategies over time.
Abstract:
This section investigates whether fairness-oriented individuals can outcompete purely self-regarding individuals in evolutionary settings. The analysis shows that disadvantageous inequity aversion leads to a stable cooperative equilibrium, whereas purely selfish behavior results in a collapse of cooperation. Mathematical modeling suggests that even a small presence of fairness-motivated individuals can lead to the spread of cooperative norms due to higher evolutionary fitness. Over time, other-regarding preferences become dominant in a population, reinforcing cooperative behaviors through punishment mechanisms.

Title: Discussion and Conclusion
Short description: Summarizes findings and their broader implications for human cooperation.
Abstract:
The study bridges the gap between evolutionary theory and empirical economics by demonstrating how fairness and punishment emerge naturally through evolutionary selection. The findings challenge traditional economic models of pure self-interest, showing that cooperation can persist even in one-shot interactions without direct personal gain. The research suggests that social norms of fairness and punishment are not just cultural constructs but have deep evolutionary roots. Future research should further explore how different environmental and social conditions influence the evolution of cooperation and punishment in human societies.