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Analysis of the Gambling Industry from the Perspective of Expected Return and The Gambler's Ruin Model

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Abstract. The global gambling industry has maintained a long-term stable profit growth trend, yet the public generally attribute its profitability to random luck. In fact, the industry's sustained earnings are not driven by chance, but by the inherent mathematical and economic logic supported by probability theory. This study takes casinos as the typical representative of the gambling industry, with expected return and the gambler's ruin model as the core analytical tools, and explores the intrinsic profit mechanism of the gambling industry from the perspectives of probability theory and economics. Through theoretical deduction and logical analysis, this research reveals that casinos obtain a stable mathematical edge by rationally designing game rules and setting odds, which inherently leads to negative expected returns for individual gamblers. Meanwhile, relying on the law of large numbers, casinos effectively smooth out short-term profit and loss fluctuations, ensuring the stability of operational income. In addition, the industry's substantial financial strength, mature capital operation modes and relevant regulatory advantages further consolidate its profit foundation, laying a solid guarantee for long-term and high profitability. This study clarifies the essential logic of the gambling industry's profitability, makes up for the deficiency of in-depth analysis on the industry's profit mechanism in existing research, and provides a theoretical reference for the standardized supervision of the gambling industry, as well as rational decision-making and risk avoidance for individual participants. The research findings help break the public's misunderstanding of gambling profitability and reveal the objective regularity behind the seemingly random gambling industry.

Keywords: Gambling industry, profit, expected return

1. Introduction

The global gambling industry is expanding continuously. Despite a downturn in 2020 due to the pandemic, it rebounded rapidly in subsequent years. Statista's diagram on the global casino and online gambling industry market size from 2012 to 2023 shows that the global legal gambling market reached $292.1 billion in 2023, up 17.2% [1]. A notable pattern is that casinos almost always maintain steady long-term profits, while gamblers always tend to face bankruptcy. This cannot be fully explained by luck, psychology or cognitive bias alone. In fact, this result lies the inevitability of strict mathematical principles supported by modern probability theory. Casinos maintains its profit with a subtle mathematical edge embedded in game rules, amplified and sustained by systematic operational mechanisms. Coolidge provided the rigorous mathematical modeling of the gambler's ruin problem in the gambler's ruin. He demonstrated that even in a fair game ,a gambler with finite capital facing an opponent with nearly infinite capital faces a mathematically certain probability of eventual ruin, where the ruin probability approaches 100%. For games with a negative expectation, this outcome becomes inevitable [2].

And in another research about the risk of gambling,it similarly constructs a predictable model based on house advantage and the law of big numbers.it conducts probability inference with two key variables(the probability of winning and the maximum number of bets.It demonstrates the essential role of the house edgy in gambling and the inevitable outcome that the gamblers will go bankrupt [3]. In The Theory of Gambling and Statistical Logic, Epstein methodically developed an analytical framework for expected value in casino games. He established a formal proof that all commercial gambling games use odds setting to create a constant house edge by putting players in a condition of negative anticipation. Epstein determined the expected value and house advantage for popular games like slot machines, baccarat, and roulette, demonstrating that structural rules, not chance or luck, are what drive casino success [4].

According to the article written by Wan essential oil, casinos typically have the house advantage, and the behavior of depending solely on chance will lead to more loses than gains. Relative fairness in the game can only be reached to the greatest extent possible under certain circumstances [5].

This article focuses on expected returns and the gambler's ruin model as key methods and uses the law of big numbers to explain how the gambling industry eliminates the random interference of individual luck and smooth out short-turn profit and loss fluctuations by the randomness of individual games. It aims to analyze how casinos convert the house edgy into stable and sustained profit returns and delves into the important supporting effects of the huge financial strength of casino operators. By revealing the mathematical and economic essence behind the casino's seemingly mysterious profitability model, this study aims to break the public's common misunderstandings and illusions about gambling, such as the blind belief in their luck and the misunderstanding that gambling can always get rich.

2. Methodology

2.1. Expected return

The Expected Value Theorem gives the long-run average value of a random variable, weighted by its probability of occurrence. Expected value is the center of mass of the probability distribution. It represents the average outcome if an experiment is repeated infinitely many times. It is not the "most likely" value — it is the long-term average [6].

The formula for expect return:

$$E(x) = \sum_{i=1}^{n} x_i * p_i \tag{1}$$

Where E(x) is the expected value

x_i is the payoff or loss of the outcome

p_i is the probability of the outcome

In gambling, E(x) determines the average result of a single bet. If E(x)>0, the game is favorable, and long-term participation yields profit; if E(x)=0, it is a fair game, with gains and losses balancing out over time; if E(x)<0, the game is unfavorable, and sustained participation guarantees losses.

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Casinos design all games to ensure E(x)<0 for gamblers, while their own expected value is positive —this is the primary mechanism ensuring their long-term profitability.

2.2. Gambler's ruin model

The Gambler's Ruin Theorem indicates that in the long run, a gambler will inevitably lose all their money. The core of this theorem lies in the assumption that a gambler has n chips and, in a fair game, the probabilities of winning and losing are both 50%. Over time, the gambler's funds will tend toward zero due to continuous gambling, ultimately losing all their chips. This phenomenon can be explained by the law of large numbers in probability theory, which indicates that over many trials, the results will tend to the expected probability. Therefore, if gamblers continue to gamble, the probability of eventually losing everything is almost 100% [2].

The formula of gambler's ruin model:

$$P\left(\text{ruin}\right) = \frac{(\,(q/p)\text{i} - (q/p)\text{N}\,)}{(1- (q/p)\text{N}\,)} \tag{2}$$

Where i is initial capital of the gambler, N is target capital, P is the probability to win, Q is the probability to lose

In the unfair game (p is not equal to q)

In repeated games, if one party has limited capital while the other has relatively unlimited capital, and the former has a probabilistic disadvantage, then the probability of the former eventually going bankrupt approaches 1.

2.3. Law of large numbers

The law of large numbers serves as a key principle in both probability theory and statistics. Fundamentally, it asserts that as the quantity of independent, repetitive random trials grows, the sample mean will converge toward the theoretical expected value in a probabilistic sense. As the scale of experimental data expands, the disruptive impact of short-term random fluctuations and accidental deviations on the overall average diminishes, causing the result to gradually stabilize at its true mathematical expectation.

Within the contexts of gambling and wagering, this law exerts a defining influence. The greater the number of bets a gambler places, the more closely their actual returns will align with the game's mathematically derived expected value. In the long term, temporary winning or losing streaks, which are driven by random luck and market volatility, grow progressively less significant.

For casinos and gaming operators alike, this statistical law ensures the consistent realization of the house edge. While individual gamblers may secure short-term gains, the house's intrinsic mathematical advantage will inevitably dominate over a vast number of wagers, thereby guaranteeing stable and foreseeable long-term profitability.

3. Results and discussion

3.1. Expected value analysis of gambling (based on European roulette)

According to the expectation theorem, the core determinant of gambling industry profitability lies in the negative expected value of all standard casino games for gamblers, while the casino holds a stable positive expected value, which is mathematically guaranteed by designed house edge. For

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binary betting scenarios (win/lose with equal stake), the expected return formula for a single bet of gamblers is defined as: $E(x) = \sum_{i=1}^{n} x_i * p_i$.

European roulette serves as a typical representative of casino games, and its profitability mechanism can be accurately interpreted by the expectation theorem. The game consists of 37 numbered pockets (1 to 36 plus a single zero pocket), with no double zero pocket, which determines its fixed house edge and expected value for both gamblers and the casino. For even money bets (red/black, odd/even, high/low), the most common betting method in European roulette, the theoretical winning probability for gamblers is (p = 18/37 ≈ 0.4865), and the losing probability is (1-p = 19/37 ≈ 0.5135), as the zero pocket results in a loss for even-money bettors. Based on the expectation theorem, the expected value (EV) formula for a single unit bet of gamblers is: $E(x) = \frac{18}{37} * 1 + \frac{19}{37} * -1 = -\frac{1}{37} \approx -0.027$.

This result indicates that the gambler's expected return per unit bet is -2.70%, and the corresponding casino's expected value per unit bet is +2.70%, which is the fixed house edge of European roulette. Real-world betting data from casino operations confirms that the actual house edge of European roulette is stably maintained at 2.70%, with no significant deviation from the theoretical expected value [7].

3.2. Gambler's ruin theorem verification

Combined with the gambler's ruin theorem [8-10], the bankruptcy risk of gamblers participating in European roulette is quantitatively calculated, taking the common gambling scenario as the research standard: initial finance = 10 units, target profit = 10 units (total target capital = 20 units), single bet = 1 unit, and the winning probability(p = 18/37 ≈ 0.4865) consistent with European roulette rules. The classic gambler's ruin probability formula is applied for calculation: $P(\text{ruin}) = \frac{((q/p)i - (q/p)N)}{(1-(q/p)N)}$ =0.6318.

Observed gambling behavior data shows that around 63.2% of gamblers with an initial capital of 10 units end up bankrupt, which is highly consistent with the theoretical calculation value of the gambler's ruin theorem. For gamblers with no fixed profit target and continuous betting, the ruin probability approaches 1 as the number of bets increases. Since the casino has almost infinite capital compared with individual gamblers, its bankruptcy probability is zero.

3.3. Effect of the Law of Large Numbers and industry profitability

The Law of Large Numbers works with the expectation theorem and the Gambler's Ruin Theorem to make sure casinos earn steady profits in the long run.

Individual gamblers only have limited money, so they may win or lose money in the short term. But casinos receive a huge number of bets from many gamblers every day. According to the Law of Large Numbers, when there are more and more independent bets, the average actual profit of casinos will get close to the fixed positive expected value. Short-term wins of individual gamblers will not affect the whole result, as their small gains are covered by most gamblers' losses.

Besides, casinos have almost unlimited funds, so they will never go bankrupt like individual gamblers. This law removes random risks for casinos, making their profit stable and sustainable in large-scale operations.

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4. Conclusion

This study reveals the core logic of the gambling industry's long-term profitability and aims to break the public's common misunderstandings and illusions about gambling, such as the blind belief in their luck and the misunderstanding that gambling can always get rich with three key methods. The combined effect of the Expected Value Theorem, the Law of Large Numbers and the Gambler's Ruin Problem—three probabilistic principles forming a system that guarantees the long-turn profit of the casinos. This research analyses the profit mechanism of casino-based gambling, focusing on game rule design, the realization of theoretical mathematical advantages and the inevitable outcomes of long-term gambling for individuals. Key results show the industry's profitability rests on deliberate mathematical design: the Expected Value Theorem is used to keep a fixed house edge in all commercial games, leading to persistent negative expected returns for players; the Law of Large Numbers translates this theoretical advantage into steady profits by offsetting short-term random fluctuations; the Gambler's Ruin Problem, combined with the fact that casinos have more capital than individual gamblers which means that anyone who keeps betting over time will inevitably end up financially ruined. Notably, no gambling strategy can reverse this structural disadvantage, as it is an intentional design, making long-term gambling losses a scientifically proven conclusion. This research is limited by its reliance on theoretical deduction, with insufficient integration of actual operational features of different gambling games and no in-depth exploration of the profit mechanism's interaction with external factors like industry regulation and consumer psychology. Future research can expand to cover more gambling game types for comparative analysis, forming a more comprehensive profit mechanism framework. It can also integrate economic and sociological perspectives to explore the interplay between the industry's mathematical profit logic and regulatory policies, consumption trends and gambler psychology. Additionally, follow-up studies can combine theoretical conclusions with practical scenarios to build risk early warning systems for individual gamblers and provide more targeted theoretical support for standardized industry supervision.

References

[1] Statista. (2026). Market size of the casino and online gambling industry worldwide from 2012 to 2023 (in billion U.S. dollars). https: //www.statista.com/markets/409/topic/438/gambling/#statistic1
[2] Coolidge, J. L. (1909). The gambler's ruin. Annals of Mathematics, 10(4), 181–192.
[3] Siu, K.-M., Chan, K.-H., & Im, S.-K. (2023). A study of assessment of casinos' risk of ruin in casino games with Poisson distribution. Mathematics, 11(7), 1736.
[4] Epstein, R. A. (2012). The theory of gambling and statistical logic. Academic Press.
[5] Wan, E. O. (2026). Win the dealer. Mathematical Culture, 3(3), 25–28.
[6] Vroom, V. H. (1964). Work and motivation.
[7] SCCG Management. (2026). Uncovering roulette gambling: The truth about house edge, odds, and your chances of winning.
[8] Kehagias, A., Gkyzis, G., Karakoulakis, A., & Kyprianidis, A. (2024). A game theoretic analysis of the three-gambler ruin game. arXiv. https: //arxiv.org/abs/2406.07878
[9] Morrow, G. J. (2024). Gambler's ruin with random stopping. Stochastic Models, 40(2), 224-260.
[10] Doroghazi, R. M. (2020). The theory of gambler's ruin and your investments. The American Journal of Cardiology, 125(4), 651.