Modeling the Role of Skill in Online Games*

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Abstract

Online gaming in India has been growing exponentially to a point where it has also now been touted as a sunrise sector and a key driver of India's vision of achieving a trillion-dollar digital economy by FY28[1]. The online gaming segment can be categorized into two segments i.e. free-to-play online games and online real money games. While there exists a perception that any form of game where the element of money is involved should be treated as betting/gambling/wagering, the legal jurisprudence in India has evolved differently. This flows from the Public Gambling Act, which sought to prohibit gambling/betting/wagering activities while exempting games of skill from the purview of such legislation. The courts in India have, on numerous occasions, dealt with the issue of what constitutes a game of skill and have consistently held that any game where the success of the player is predominantly dependent on the skill of such player be considered a game of skill and will be distinct from betting/gambling/wagering activities. Courts have also opined that the involvement of money in such games of skill will not alter its nature. While courts in India have laid down principles to determine what amounts to a game of skill, there is at present no quantitative framework that is agnostic to a gaming format that can statistically determine the predominance of skill in any online game. This paper aims to develop a theoretical framework for skill accumulation arising from experience and tests its role in determining outcomes in conjunction with game uncertainty. The paper develops a generalized scoring framework and employs it to test the dominance of skills using seven statistical tests. The combination of seven statistical tests will provide a comprehensive framework for testing the predominance of skill in any online game regardless of the involvement of real money in the game.

JEL Classification: D91, D81, D31, J24

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1 India to be $1 trillion digital economy by FY28: IT minister Rajeev Chandrasekhar, The Economic Times, Accessed on June 13, 2024 using following link.

1 Introduction

In recent years, online games have gained considerable popularity worldwide, especially in India. As per a report by EY, India is home to the second-largest user base of gamers with 42.5 crore users. In 2023, India saw downloads of over 430 crore mobile games, accounting for 15.3% of total global downloads. Further, the combined number of downloads in the next two countries in the list, namely the USA and Brazil, was less than the total number of gaming application downloads in India. It is estimated that the online gaming segment will grow at 15% CAGR to reach INR 33,243 crores by FY28. As the online gaming industry in India continues to grow at an exponential rate with dynamic formats, it will require innovative regulatory designs to ensure the presence of an appropriate distinguishing mechanism between games of skill and games of chance, as the latter is against the public policy of the State and is prohibited in many parts of the country. Further, since technology will always outpace regulations, it is important for policymakers to provide a more nimble and agile framework to conclusively determine the dominance of skill in any online gaming format, through objective and scientific means.

1.1 Evolution of State Gaming/Gambling Laws

The prohibition of physical gambling and betting activities in India primarily stems from The Public Gambling Act, 1867 (PGA). This colonial-era legislation was designed to curb gambling activities across the country. PGA stands as the earliest legislative acknowledgment of the distinction between games of skill and games of chance. It underscored the clear demarcation between games in which outcomes are influenced by chance, independent of a player's skill, and those where success hinges on the player's skill quotient.

The Indian Constitution, through Entry 34 of List II (State List), Seventh Schedule, grants state governments the authority to legislate on matters concerning "betting and gambling." This entry empowers states to frame laws and regulations specific to their jurisdiction regarding these activities. As a result, various states in India have adopted different approaches towards gambling and betting:

a. **Adoption of the PGA with Modifications:** Many states have incorporated the PGA into their legal framework, often with minor modifications or amendments. These states have exempted games of skill while prohibiting gambling and betting activities.

b. **State-Specific Gambling Laws:** Some states such as the State of Andhra Pradesh, Telangana, etc. have enacted their own comprehensive laws to address gambling and betting. These states have expanded the definition of gambling to include both games of chance and games of skill when there is an involvement of money. Pertinently, similar legislation in states like Tamil Nadu and Karnataka faced legal challenges. The respective High Courts ruled that banning games of skill when played for money exceeds the legislative authority of the state and is unconstitutional.

1.2 Jurisprudence on the distinction between games of skill and games of chance

The differential legal treatment of 'games of skill' and 'games of chance' has long been a distinctive feature of Indian jurisprudence. The Supreme Court has time and again dealt with this issue and has consistently applied the predominance test affirming that games of skill are not encompassed within the scope of "betting and gambling." A pivotal case in this context is RMD Chamarbaugwala vs Union of India[2], dating back to 1957 wherein the Court categorized competitions into those predominantly based on skill ('games of skill') and those primarily dependent on chance ('games of chance'). The Supreme Court also recognized that the offering of 'games of skill' is a legitimate business activity, safeguarded by the protections

2 R.M.D. Chamarbaugwala v. Union of India, AIR 1957 SC 628

outlined in Article 19(1)(g) of the Indian Constitution. In contrast, 'games of chance' have traditionally been regarded as activities falling outside the realm of commerce i.e. res extra commercium activities.

Further, distinguishing between 'games of skill' and 'games of chance', the Supreme Court in K.B. Lakshmanan v. State of Tamil Nadu[3] held that:

"[In a] game of skill [...] although the element of chance necessarily cannot be entirely eliminated, is one in which success depends principally upon the superior knowledge, training, attention, experience and adroitness of the player."

There is also a series of subsequent judicial pronouncements that have delved into the critical issue of skill preponderance in online gaming[4] and have consistently applied a predominance test to hold such games, whether there is an involvement of money or not[5], and have consistently applied a predominance test to classify such games, whether involving money or not, to be a game of skill not amounting to gambling, betting, or wagering.

1.3 Central Government initiatives to regulate online gaming

It is important to note that the scope of the Public Gambling Act (PGA) is limited to physical common gaming houses and fails to address gambling and betting activities conducted over the Internet, where servers can be located anywhere in India or abroad. The Central Government of India took a significant step in introducing a regulatory framework for online gaming. By amending the Government of India (Allocation of Business Rules), 1961, the

3 Dr. K.B. Lakshmanan v. State of Tamil Nadu, 1996 SCC (2) 226

4 Avinash Mehrotra v. State of Rajasthan, Special Leave Petition (Civil) Diary No(s). 18478/2020; Varun Gumber vs. Union of India - Review Petition (Civil) Diary No(s). 5195 of 2022; Avinash Mehrotra v. Union of India, Special Leave to Appeal (C) No(s). 15791/2022; Saahil Nalwaya v. State of Rajasthan, D.B. Civil Writ Petition No. 2026/2021; Ravindra Singh Chaudhary v. Union of India, D.B. Civil Writ Petition No. 20779/2019; Chandresh Sankhla v. The State of Rajasthan, D.B. Civil Writ Petition No. 6653/2019; Gurdeep Singh Sachar v. Union of India, SLP(Criminal) Diary No. 43346/2019; Varun Gumber v. Union Territory, Chandigarh, Diary No(s). 27511/2017; Gurdeep Singh Sachar v. Union of India, Criminal Public Interest Litigation (St.) NO. 22 of 2019; Varun Gumber v. Union Territory, Chandigarh, CWP No.7559 of 2017.

5 Head Digital Works Private Ltd. and Ors. v. State of Kerala, W.P.(C)Nos.7785, 7851, 7853 & 8440 of 2021; All India Gaming Federation v. The State of Karnataka, W.P. No. 18703/2021; All India Gaming Federation v. The State of Tamil Nadu, W.P.No.13203 of 2023; Junglee Games India Private Limited v. The State of Tamil Nadu, W.P.No.18022 of 2020.

government designated the Ministry of Electronics and Information Technology (MeitY) as the nodal ministry for online gaming.

Further, on April 6, 2023, MeitY exercised its rule making powers under the Information Technology Act 2000 to introduce a new legal framework for online gaming. These amendments, incorporated into the Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021 were introduced with the primary objective to regulate online gaming intermediaries and permit only legitimate online games to operate within the territory of India. These regulations impose an obligation on intermediaries to ensure that only permissible online real money games are hosted and made accessible.

MeitY has adopted a co-regulatory approach, aiming to recognize independent Self-Regulatory Bodies (SRB) that meet prescribed eligibility criteria and empower them to verify online real money as permissible online real money game based on Rule 4A and the verification framework enacted by them. Rule 4A (3) of the rules outlines the basic criteria for SRBs for determining online real money as permissible online real money game i.e. the game shall not involve wagering on any outcome and that it complies with the due diligence obligations prescribed under the Rules.

1.4 Interpretation of the term wager

The term "wager" or "wagering" lacks a statutory definition in Indian law, including the IT Rules. In the context of a challenge to the Prize Competitions Act, 1955, a constitutional bench of the Supreme Court, in the case of State of Bombay v. R. M. D. Chamarbaugwala[6], purposefully interpreted the Act. Crucially, the Court drew a clear distinction between competitions that involve substantial skill and those that are based on chance. The Court implied that competitions involving skill, such as games of skill played for stakes, should

6 R.M.D. Chamarbaugwala v. Union of India, [AIR 1957 SC 628].

be treated akin to commercial contracts. In contrast, gambling activities, characterized by games of chance involving stakes, were equated with wagering contracts.

International precedent[7] also shows that 'wagers' are seen as referring to stakes on contests of chance and not to stakes on contests of skill. For example, the New York Court of Appeals in White v. Cuomo[8] relied on contract law principles to interpret legislative action, holding that if the outcome of contests is dependent upon skill rather than chance, then a stake in the outcome of such contests cannot be termed as a 'wager'.

This comparison suggests a logical corollary: wagering contracts are inherently associated with gambling, and games of skill fall outside the purview of wagering contracts. Consequently, games of skill played for money are not deemed to be in the nature of 'wagers,' according to the interpretation provided by the Court. This nuanced understanding serves to underline the legal distinction between games of skill, on the one hand, and gambling, betting, or wagering, on the other hand, reinforcing the idea that skill-based contests are treated differently from gambling, betting, or wagering activities.

Thus, it is evident that in the Indian legal context, the distinction between games of skill and games of chance is of paramount importance, especially in the realm of State gambling law and Central gaming rules. While some jurisprudence has attempted to draw a line between games of skill and chance, so far, an objective set of tests suitable for application across gaming formats, has eluded scholars as well as the industry.

To this end, the relative role of skill in determining the outcome of online games holds paramount importance in India as it differentiates it from wagering, especially as the government works towards establishing a regulatory framework for online games (see Misra et al., 2020). This distinction also carries significant legal and regulatory implications as it will ensure that any online gaming format that is against the public policy of the State, i.e.

7 Dew-Becker v. Wu, 2020 IL 124472 (U.S.); Humphrey v. Viacom, Inc.
8 White v. Cuomo, 2022 NY Slip Op 01954.

such a game promoting gambling, betting, or wagering, is not allowed to operate under the umbrella of online gaming.

This study is centered on evaluating the relative significance of skill in determining the outcomes of online gaming contests entered by users. The statistical evidence derived from the hypothesis tests conducted in this research indicates that while luck may have some impact on an individual user's performance, skillful management and decision-making consistently yield a higher probability of long-term success.

If a game's outcome is determined purely by luck, the player's skill is irrelevant, making it indistinguishable from wagering. However, if the game's outcome is not completely random and the outcome is based on the player's game expertise, then the role of skill in the game cannot be ruled out. This research paper develops a theoretical framework for scoring functions in online games and assesses the relative role of skill in determining game outcomes using seven statistical tests. We are of the view that if any online game, regardless of the format, satisfies the conditions of the tests listed below, it should be classified as a 'game of skill' and therefore should be differentiated from wagering. The list of tests is as follows:

i. Test 1: A skilled contestant always beats a contestant opting for a random strategy.

ii. Test 2: Contestants have an opportunity to deliberately lose a contest.

iii. Test 3: Higher skill reflects better winning probability in online games.

iv. Test 4: Relative superiority of skill remains consistent across non-overlapping time intervals.

v. Test 5: Experience helps in attaining skills.

vi. Test 6: Similar skilled players have similar win percentages.

vii. Test 7: Consistent winning is not an event of chance.

The primary aim of the above seven tests is to examine the preponderance of skill in determining the outcome of online games. Therefore, it is appropriate to ask whether the game is not a pure game of chance such as rolling of dice and tossing of coin. Articulating the game of chance, Miles et al. (2013) set forth four characteristics to distinguish games of pure chance from those involving skill. These characteristics are as follows: first, all players of the game are supposed to have equal expected payoffs. Second, there does not exist any ex-ante signal that helps predict the payoff of the players. Third, the actions of the players do not have any impact on the payoffs. Fourth and last, the player's payoffs are not correlated over time which shows the player's skill is not persistent in driving payoffs.

Following the framework characterized by Miles et al. (2013), we propose seven tests along with the hypothesis to assess the online games across the above-stated four themes. Test 1 helps us to validate the first characteristic that expected payoffs across players are not the same. Test 2 shows that the player's actions impact their payoff. Next, Test 3 shows that there exist ex-ante signals in online games that signal a player's payoff. Test 4 shows the persistence of skill across the different plays of the games while Test 5 explores the opportunity of learning by doing and establishes the role of experience in attaining skill. The last two tests, namely Test 6 and Test 7 do the robustness check on the legitimacy of the above four strands of tests. Test 6 shows that the signals of ex-ante characteristics are robust and help in determining the confidence interval of game payoff based on skill. The last test establishes the impossibility of a scenario where a game satisfies all four strands of tests while being a game of pure chance.

Together, these seven tests form a comprehensive framework as they involve all four strands of the testing framework as developed by Miles et al. (2013) and also perform further robustness checks. Furthermore, the framework here does not utilize the online gaming rules and hence the game can be used as a black box and can be tested for the preponderance of skill in determining its outcome.

In line with our work, there is an extant scholarly work that tests the role of skill in online games. For instance, Getty et al. (2018) introduce a framework based on variance in winning probability to test the role of skill in a variety of games including professional sports, fantasy sports, cyclocross racing, coin flipping, and selection of mutual funds. The role of skill in the selection of mutual funds can be seen as analogous to the application of skill in online fantasy sports as once the user chooses their team, they have no control over the performance of their chosen team which is similar to the relationship of investor with fund manager after the investor chooses to invest in a particular fund (see Cai et al., 2018). In the context of card games, the work of Croson et al. (2008) and Hannum and Cabot (2009) assess the role of skill in the game of Poker while Larkey et al. (1997), Miles et al. (2013) and van der Genugten and Borm (2016) study the role of skill in Texas Hold'em. Easton and Newell (2019) and Aishvarya et al. (2024) study the role of skill in the context of fantasy sports. Using the evidence from gambling, Orkin (2021) shows that the winning probability is considerably skewed in a game of skill and shows the observed winning percentages in those games are impossible in the game of pure chance.

The main contribution of our research is to propose a framework agnostic of game format that can help determine the role of skill in driving the outcome of the game. To establish this, we formulate a scoring function that captures the components of skill and chance driving the player's score in the game. Using this scoring function, we then test whether the proposed formulation of the scoring function aligns with the actual user scores on an online gaming platform. After validating the structure of the scoring function, we examine whether a game that follows such a scoring function meets the benchmarks of the seven hypothesis tests mentioned earlier to assess the dominance of skill in online games. The seven tests employed in our paper have universal applicability for evaluating the prominence of skill in any online game where players' actions can be summarized using a consolidated scoring function developed in this paper.

The subsequent sections of the paper are structured as follows. In Section 2, we propose and validate the functional characteristics of the scoring function. Section 3 presents the comprehensive conditions for the seven statistical tests that are required to show the dominance of skill in determining the outcome in the context of online games. Ultimately, Section 4 completes the paper with concluding remarks highlighting the important implications of adopting this framework from a public policy perspective.

2 A theoretical framework for assessing skill in online games

In this section, we present a theoretical framework aimed at understanding the mechanism of collecting online gaming scores, and using the framework we infer how the outcome of such contests is dominated by the skill of the players involved in the contests. In a game of complete information[9], ex-ante, the players get complete information about the game conditions at the beginning. Kamath (2022) provides a literature review about the classification of games based on the availability of information to the participating players about the game rules and the payoff received by other players. For example, the bidders are aware of the value of the product in the auction games, but they may not be sure about the strategies of other bidders. In a fantasy game based on a real cricket match, the contesting participants have full information about the statistics of the players participating in the real sporting events along with rules, weather, and other local conditions affecting the performance of players in the actual sports events, but may be unaware about the team chosen by other players at

9 In a complete information game, the knowledge about the game structure and other players' characteristics are known to the players, while in perfect information, the players are aware of all the actions taken by players during the game. Perfect information games are in general sequential and players make decisions under the full knowledge about the historical moves taken by the players while in complete information game, the players may have uncertainty about the moves taken by other players in the game.

the start of the game. As a result, we can treat such games as complete information games. Armed with statistics, players apply their skills and draft a team to maximize their fantasy points on the leaderboard. However, it is worth noting that even though the participants desire to maximize their fantasy score, they have no control over the performance of the players participating in the real sports events. These uncontrollable factors do affect their fantasy scores. In our framework, we pool all such factors under the chance component of the utility function which defines the fantasy scores attained by participating contestants. Analogously, we can view the game scores collected by gaming contest participants consisting of two components where one component captures the skill of the participant while the other component stands for chance involved in the online game.

Under the above-stated framework, the utility function presenting the scores in the online game is following:

$$u(Z, X) = Z + X$$

where the pooled skill, experience, and learning of the contestant is represented by Z which is always positive for a contestant who is trying to win the contest, and the role of chance is represented by X which is also positive. The distribution of Z is determined by the personal traits of the contestant, whereas the chance variable X is independently and identically distributed for all the contestants. By construction, the consolidated score attained by a contestant is an increasing function of skill and chance, i.e.

$$\frac{\partial\, \mathbb{E}\left(u(Z, X)\right)}{\partial\, Z} > 0, \quad (u(Z, X = \theta) - u(Z, X = 0)) > 0. \tag{1}$$

The skill level Z is the result of experience-based learning and can be presented as:

$$Z(\Lambda, \lambda, e) = \Lambda - \kappa\, exp(-\lambda\, e) > 0$$

where $\kappa > 0$ and $\delta > 0$ such that $\Lambda = (\kappa + \delta) > 0$ is the limiting skill level attained by a contestant by virtue of experience. The term $\delta > 0$ is the innate skill, κ is a skill multiplier and $\lambda > 0$ is the learning rate of a contestant from his experience while $e \in \{1, 2, 3, \ldots, E\}$ is the level of experience which is measured in terms of the number of matches of online game played. On the other hand, the contestant gets a score θ when the chance favors him. The score due to chance is positive but numerically smaller than the limiting skill level which is $(0 < \theta << \Lambda)$. Hence, the score as a result of chance can be summarized using the Bernoulli distribution:

$$X = \begin{cases} \theta & \text{with probability } p \\ 0 & \text{with probability } 1 - p \end{cases}$$

We further assume that there are N contestants who play for E rounds of play. Therefore, the total number of online game scores collected by a contestant with $i \in \{1, 2, 3, \ldots, N\}$ with $e \in \{1, 2, 3, \ldots, E\}$ years of experience is

$$u_i(Z, X) = \begin{cases} \Lambda_i - \kappa\, exp(-\lambda_i\, e) + \theta & \text{with probability } p \\ \Lambda_i - \kappa\, exp(-\lambda_i\, e) & \text{with probability } 1 - p \end{cases}$$

The above shows that a favorable chance event helps the score of the contestant while their skill based score is a function of his learning rate, experience, and limiting skill level. The limiting skill level is innate to each participant.

3 A characterization of the dominance of skill in the online games

3.1 Skilled user always beats a random simulation

Let's consider any two contestants a and b, where a is applying their skill to collect online game scores across the E rounds of contests while b is just attempting random strategy. Therefore, the average score of a over E rounds of contests

$$\bar{u}(Z_a, X) = \frac{1}{E}\sum_{e=1}^{E} u(Z_{a,e}\, X) = \Big(\frac{1}{E}\sum_{e=1}^{E}(\Lambda_a - \kappa\, exp(-\lambda_a\, e)) + p\,\theta\Big)$$

and the average score of a contestant b who is applying pure random strategy is

$$\bar{u}(Z_b = 0, X) = \frac{1}{E}\sum_{e=1}^{E} u(Z_{b,e} = 0,\; X) = p\,\theta$$

By construction, the skill based online game scores $\frac{1}{E}\sum_{e=1}^{E}(\Lambda_a - \kappa\, exp(-\lambda_a\, e)) > 0$ is strictly positive, therefore

$$P\Bigg(\Big(\bar{u}(Z_a, X) - \bar{u}(Z_b = 0, X)\Big) > 0\Bigg) = 1.$$

The result shows that a skilled contestant attains higher online game scores as compared to a contestant opting for a random strategy and not applying their skill. Hence, a skilled contestant always beats a contestant opting for a random strategy.

3.2 Opportunity to deliberately lose a contest

Likewise in Section 3.1, we consider two contestants a and b, where b is again opting for a random strategy to score in an online game. Contrary to their action in Section 3.1, contestant a is deliberately applying his skill to select a strategy that may provide them with the lowest possible game scores. As a result, the contribution skill to their consolidated score can be considered negative. Hence, the average score of a over E rounds of contests

$$\bar{u}(Z_a, X) = \frac{1}{E}\sum_{e=1}^{E} -u(Z_{a,e}\, X) = \Big(\frac{-1}{E}\sum_{e=1}^{E}(\Lambda_a - \kappa\, exp(-\lambda_a\, e)) + p\,\theta\Big)$$

and the average score of contestant b who is applying pure random strategy is

$$\bar{u}(Z_b = 0, X) = \frac{1}{E}\sum_{e=1}^{E} u(Z_{b,e} = 0,\; X) = p\,\theta$$

By construction, the skill based score $\frac{-1}{E}\sum_{e=1}^{E}(\Lambda_a - \kappa\, exp(-\lambda_a\, e)) < 0$ is strictly negative, therefore,

$$P\Bigg(\Big(\bar{u}(Z_a, X) - \bar{u}_b(Z_b = 0, X)\Big) < 0\Bigg) = 1.$$

The result shows that when a skilled contestant applies his skill in such a way that it yields a negative or sub-zero score due to which, they score lower than the contestant opting for a random strategy and as a result, they lose to a contestant opting for a random strategy.

3.3 Higher skill reflects better winning probability

Again, we consider two contestants, a and b, both applying their skills to score in the game during the contests. However, a and b are different in the sense that a is more skilled than b. Without loss of generality, we assume the limiting skill level and learning rate of contestant a is greater than the limiting skill level and learning rate of contestant b, i.e.

$$\Lambda_a > \Lambda_b \quad \text{and} \quad \lambda_a > \lambda_b$$

After E rounds of contest, the average score of player a is

$$\bar{u}(Z_a, X) = \frac{1}{E}\sum_{e=1}^{E} u(Z_{a,e}\, X) = \Big(\frac{1}{E}\sum_{e=1}^{E}(\Lambda_a - \kappa\, exp(-\lambda_a\, e)) + p\,\theta\Big)$$

and the average score of a contestant b is

$$\bar{u}(Z_b, X) = \frac{1}{E}\sum_{e=1}^{E} u(Z_{b,e}\, X) = \Big(\frac{1}{E}\sum_{e=1}^{E}(\Lambda_b - \kappa\, exp(-\lambda_b\, e)) + p\,\theta\Big)$$

Further, the difference in average score between contestants a and b can be written as

$$\bar{u}(Z_a, X) - \bar{u}(Z_b, X) = \frac{1}{E}\sum_{e=1}^{E}\Big(u(Z_{a,e}\, X) - u(Z_{b,e}\, X)\Big) = \Big(\frac{1}{E}\sum_{e=1}^{E}(\Lambda_a - \Lambda_b) + \kappa\,(exp(-\lambda_b\, e) - exp(-\lambda_a\, e))\Big)$$

By construction, the limiting skill of contestant a is greater than contestant b, therefore $(\Lambda_a - \Lambda_b) > 0$, skill multiplier $\kappa > 0$, and further the learning rate of contestant a is also greater than contestant b, hence $(exp(-\lambda_b\, e) - exp(-\lambda_a\, e)) > 0$. Under the above conditions, we would see that

$$\bar{u}(Z_a, X) - \bar{u}(Z_b, X) > 0$$

As a result, we can show

$$P\Bigg(\Big(\bar{u}(Z_a, X) - \bar{u}_b(Z_b = 0, X)\Big) > 0\Bigg) = 1.$$

Therefore, a higher skill rate reflects a better winning probability of the contestant.

3.4 Skill always dominates chance

Following the contestants' specification in Section 3.1, a and b are two contestants, where a applies their skill to collect game scores across the two disjoint durations, firstly during the first E_1 contests and the next E_2 rounds of contests, whereas in both durations b persists with their random strategy. Therefore, the average score of a over E_1 rounds of contests

$$\bar{u_{E_1}}(Z_a, X) = \frac{1}{E_1}\sum_{e=1}^{E_1} u(Z_{a,e}\, X) = \Big(\frac{1}{E_1}\sum_{e=1}^{E_1}(\Lambda_a - \kappa\, exp(-\lambda_a\, e)) + p\,\theta\Big)$$

and the average score of a contestant b during those E_1 rounds of contests applying pure random strategy is

$$\bar{u_{E_1}}(Z_b = 0, X) = \frac{1}{E_1}\sum_{e=1}^{E_1} u(Z_{b,e} = 0,\, X) = p\,\theta$$

Similarly, the consolidated scores corresponding to contestants a and b during next E_2 rounds of contests is

$$\bar{u_{E_2}}(Z_a, X) = \frac{1}{E_2}\sum_{e=E_1+1}^{(E_1+E_2)} u(Z_{a,e}\, X) = \Big(\frac{1}{E_2}\sum_{e=E_1+1}^{E_1+E_2}(\Lambda_a - \kappa\, exp(-\lambda_a\, e)) + p\,\theta\Big)$$

and

$$\bar{u_{E_2}}(Z_b = 0, X) = \frac{1}{E_2}\sum_{e=E_1+1}^{E_1+E_2} u(Z_{b,e} = 0,\, X) = p\,\theta$$

Using the results from Section 3.1, we can say that for any sufficiently large E_1 and E_2, the skilled contestant dominates the score of a contestant adopting a random strategy by just relying on chance. Therefore, by construction

$$\Big(\bar{u_{E_1}}(Z_a, X) - \bar{u_{E_1}}(Z_b = 0, X)\Big) > 0 \quad \text{and} \quad \Big(\bar{u_{E_2}}(Z_a, X) - \bar{u_{E_2}}(Z_b = 0, X)\Big) > 0$$

using the above result, we can say that a skilled contestant always dominates over the contestants applying a random strategy

$$P\Bigg(\Big((u_{\bar{E_1}}(Z_a,X) - u_{\bar{E_1}}(Z_b=0,X)) > 0\Big) \bigcap \Big((u_{\bar{E_2}}(Z_a,X) - u_{\bar{E_2}}(Z_b=0,X)) > 0)\Big)\Bigg) = 1.$$

The result shows that for any amount of sufficiently large disjoint duration, the skilled contestant dominates over the contestants opting for a random strategy for collecting scores.

3.5 Experience helps in attaining skill

To show the role of experience in attaining skill, we consider two contestants a and b, with equal limiting skill Λ and learning rate λ. The only difference between them is the amount of experience they possess at the start of the E rounds of contests. The level of experience at the start of the contest is e_a and e_b respectively, and we assume that $e_a > e_b$. After E round of contests, the average score of a is

$$\bar{u}(Z_a,X) = \frac{1}{E}\sum_{e=1}^{E} u(Z_{a,e}\,X) = \Big(\frac{1}{E}\sum_{e=1}^{E}(\Lambda - \kappa\, exp(-\lambda\,(e_a+e))) + p\,\theta\Big)$$

while the average score of contestant b is

$$\bar{u}(Z_b,X) = \frac{1}{E}\sum_{e=1}^{E} u(Z_{b,e}\,X) = \Big(\frac{1}{E}\sum_{e=1}^{E}(\Lambda - \kappa\, exp(-\lambda\,(e_b+e))) + p\,\theta\Big)$$

Therefore, the difference between their average score is

$$\bar{u}(Z_a,X) - \bar{u}(Z_b,X) = \frac{1}{E}\sum_{e=1}^{E} \lambda\,\kappa\, exp(-e)\Big(exp(-\lambda\, e_b) - exp(-\lambda\, e_a)\Big)$$

By assumption, $e_a > e_b$ which implies $\lambda e_a > \lambda e_b$ for any $\lambda > 0$, which in turn implies that $exp(-\lambda e_a) < exp(-\lambda e_b)$, which leads to $(exp(-\lambda\, e_b) - exp(-\lambda\, e_a)) > 0$, and hence $\big(\bar{u}(Z_a,X) - \bar{u}(Z_b,X)\big) > 0$. Using the result above, we can say

$$P\Big((\bar{u}(Z_a, X) - \bar{u}(Z_b, X)) > 0\Big) = P\left(\frac{1}{E}\sum_{e=1}^{E} \lambda\, exp(-e)\Big(exp(-\lambda\, e_b) - exp(-\lambda\, e_a)\Big) > 0\right) = 1.$$

Therefore, the experience helps the contestants to attain the skill which further helps them in improving their probability of getting higher game scores, which ultimately helps their chances of winning the contests.

3.6 Similar skilled players have similar win percentages

Let's consider two contestants a and b with similar levels of skills. In other words, we say they have similar limiting skill levels, similar learning rates, and experience levels i.e.

$$\Lambda_a \equiv \Lambda_b = \Lambda \quad , \quad \lambda_a \equiv \lambda_b = \lambda \quad \text{and} \quad e_a = e_b = e \implies Z_a = Z_b = Z$$

As the skills of these two players are similar, they are expected to have a similar win percentage against a contestant c with a given skill. Compared to the contestant, the difference in performance of a compared to c and the contestant b compared to c arises from the chance component of their game scores. Further, in the theoretical framework of the model, the chance component is identically distributed across players which shows that contestants a and b have identical leverage against player c.

Moreover, we can extend this logic and say that if they (a and b) participate in a series of contests against each other they are expected to have an equal win probability against each other. The chance factor for both players a and b follow Bernoulli distribution and both of independent, therefore the distribution of $X_a - X_b$ is

$$X_a - X_b = X_b - X_a = \begin{cases} -\theta & \text{with probability } p(1-p) \\ 0 & \text{with probability } (1-p)(1-p) + pp \\ \theta & \text{with probability } (1-p)p \end{cases}$$

After K rounds of the contest, the average difference between their game scores will be equivalent to the difference in their score by chance, which means

$$\bar{u}(Z_a, X) - \bar{u}(Z_b, X) = \frac{1}{E}\sum_{e=1}^{E}(X_a - X_b) \quad \text{and} \quad \bar{u}(Z_b, X) - \bar{u}(Z_a, X) = \frac{1}{E}\sum_{e=1}^{E}(X_b - X_a)$$

Utilizing the result above, we can say that $(\bar{u}(Z_a, X) - \bar{u}(Z_b, X))$ and $(\bar{u}(Z_b, X) - \bar{u}(Z_a, X))$ are identically distributed and further the winning probability of one against either contestant should be equal, which we can express as follows

$$P\Big((\bar{u}(Z_a, X) - \bar{u}(Z_b, X)) > 0\Big) = P\Big((\bar{u}(Z_a, X) - \bar{u}(Z_b, X)) < 0\Big) = p(1-p).$$

3.7 Consistent winning is not an event of chance

To prove that consistent winning is not an event of chance, we assume that there is a contest between N players where players are participating are not utilizing their skills but are just relying on their chance, and we further assume that there is a player a, who is winning consistently which means

$$u(X_a) = X_a > max_{i \neq a}\{X_1, X_2, X_3, \ldots, X_N\}$$

As we know all X_i are independently distributed and follow Bernoulli distribution. This is equivalent to the event where X_a is observing θ while all others are observing 0. We can write the above event as follows

$$p(X_a > max_{i \neq a}\{X_1, X_2, X_3, \ldots, X_N\}) = p(X_a = \theta \cap X_1 = 0 \cap X_2 = 0, \cap X_3 = 0, \ldots, \cap X_N = 0)$$

Using the independence of chance component across contestants, the probability of having such an event is

$$p(X_a > max_{i \neq a}\{X_1, X_2, X_3, \ldots, X_N\}) = p(1-p)^{(N-1)}$$

As the $N \to \infty$, this probability converges to zero. Therefore, a consistent win in a skill based online game cannot be an event of chance.

4 Concluding remarks

The strength and beauty of online games lie in the fact that players utilize their information about game conditions and participating players in the contests to build a strategy based on solid statistical foundations to outscore their competitors. Recent statistics indicate that close to half a billion users participate in online contests. Despite their overwhelming popularity, there is no standard framework for evaluating the dominance of skill in determining the outcomes of such games. In India, distinguishing between games of skill and games of chance is paramount, especially within gambling and gaming laws in addition to the discussion questioning the legitimacy and welfare contributions of businesses offering such games.

Further, in the absence of an objective framework to distinguish games of skill from games of chance, unscrupulous platforms, from India and outside, that offer games of questionable legality continue to proliferate in India. These platforms, offering betting, gambling, and wagering services under the guise of legitimate game formats, pose significant risks to user safety and national security. The need for a game testing framework that can categorically distinguish games of skill from games of chance is, therefore, immediate and key to ensuring effective governance and protecting the interests of Indian users.

In the context of the precedence-based legal system of India, it is beneficial to refer to established legal norms when forming policies to ensure consistency with ground realities. For instance, consider online chess competitions, only a few are rewarded for their persistence and hard work, while most of the participants lose. The key takeaway is that while everyone invests in preparing for these competitions, only a few succeed because of their skill, which is a requirement for having a positive probability of success, similarly, online games reward those who invest their time and show persistence in honing the game skills, while a majority of them who participate in such contests for recreation without working on their skills, may end up not winning.

Therefore, there is a need for an objective framework to determine whether an online game is a game of skill or a game of chance. To develop this framework, we follow industry-established literature testing heterogeneity in payoffs based on skill and the impact of players' ex-ante characteristics on their final payoffs. We further test skill persistence, the opportunity for learning by doing followed by robustness tests. These tests together form a framework for assessing the preponderance of skill in any online game.

The tests do not explicitly use the games' structure but treat it as a black box where players' performance is summarized into a consolidated score. We further show that such a structure of scoring function is indeed supported by real user data on an online gaming platform. The derived scoring function shows that contestants accumulate skills with experience. Although game uncertainty has a role in impacting collected scores, the role of skill ultimately emerges as the determinant of game outcomes in the long run. The study provides a game rule-agnostic policy framework for summarizing players' performance into consolidated scores to test the preponderance of skill.

These findings have important implications for public policy, raising awareness about online games and proposing a coherent framework to distinguish predominantly skill-based games from games of chance. This sets the basis for a regulatory structure to recognize such games as legitimate business activities.

References

Aishvarya, Das, T., and Kumar, U. D. (2024). Decision support system for policy-making: Quantifying skill and chance in daily fantasy sports. *Decision Support Systems*, 182:114237.

Cai, B., Cheng, T., and Yan, C. (2018). Time-varying skills (versus luck) in US active mutual funds and hedge funds. *Journal of Empirical Finance*, 49:81–106.

Croson, R., Fishman, P., and Pope, D. G. (2008). Poker superstars: Skill or luck? Similarities between golf—thought to be a game of skill—and poker. *Chance*, 21(4):25–28.

Easton, T. and Newell, S. (2019). Are daily fantasy sports gambling? *Journal of Sports Analytics*, 5(1):35–43.

Getty, D., Li, H., Yano, M., Gao, C., and Hosoi, A. E. (2018). Luck and the law: Quantifying chance in fantasy sports and other contests. *SIAM Review*, 60(4):869–887.

Hannum, R. C. and Cabot, A. N. (2009). Toward legalization of Poker: The skill vs. chance debate. *UNLV Gaming Research & Review Journal*, 13(1).

Kamath, N. (2022). Games of skill vs Games of chance - A principles-based framework to recognise the difference. *Law in Sport, blogs.*

Larkey, P., Kadane, J., Austin, R., and Zamir, S. (1997). Skill in games. *Management Science*, 43:596–609.

Miles, T. J., Levitt, S., and Rosenfield, A. M. (2013). Is Texas Hold'Em a game of chance? A legal and economic analysis. *Georgetown Law Journal*, 101:581.

Misra, V., Shah, D., and Ranganathan, V. (2020). Is it luck or skill: Establishing role of skill in mutual fund management and fantasy sports. *Massachusetts Institute of Technology.*

Orkin, M. (2021). Games of chance and games of skill. *Chance Editorial.*

van der Genugten, B. and Borm, P. (2016). Texas Hold'em: A game of skill. *International Game Theory Review*, 18(03):1650005.