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How Do Loot Box Probabilities Affect Secondary Market Prices and Player Choices in Video Games

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Abstract. This study aims to investigate how the probability of winning in video game gacha systems influences players' choices regarding the acquisition of virtual skins, as well as the relationship between this probability mechanism and secondary market prices. Taking Identity V as the research object, this paper focuses on its Gold-level skins; the official base drop probability for this kind of skin is 0.7%, each single draw is priced at 9.6 yuan, and for players who have not received any gold skin, the game will give out a guaranteed gold skin on the 200th draw. Under this setting, the study calculated the cumulative probability of obtaining a gold skin with different draw numbers, and it also worked out the corresponding spending; these computed results were then compared with the real-world prices of various gold skins available on the secondary market. Several basic economic concepts, such as scarcity, supply and demand, as well as opportunity cost, were applied in this paper to illustrate the price gap that exists between these two markets. According to the calculation results, players will have a higher probability of receiving a gold skin when they carry out more draws; meanwhile, the 200-draw cap prevents players from making an unlimited number of attempts. Data collected from the secondary market also presents huge price differences among gold skins; some permanent gold skins are traded at roughly 120-200 yuan, whereas rare, widely-favoured or skins that are no longer released can be sold for several thousand yuan.

Keywords: Loot Boxes, Probability, Secondary Market, Virtual Skins, Player Choice

1. Introduction

Loot boxes are a random reward mechanism whereby players pay for the chance to obtain in-game items [1]. This model has become one of the mainstream monetisation methods in the video game industry. The global video game industry has experienced significant growth, with free-to-play games increasingly relying on in-game purchases and virtual goods as their primary sources of revenue. Among the various implementations of loot box mechanics, the asymmetrical competitive mobile game Identity V, developed by NetEase, employs a gacha style system based on Essences and Treasures, yielding items ranging from common to the highest-quality "Gold Skins".

The probability structure of the Identity V loot box system is categorised by rarity and features a cumulative guaranteed drop mechanism. The drop rates for Common (white) and Uncommon (green) items are 31.7% and 49.8% respectively; the base drop rate for Rare (blue) items is 15.3%,

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but one is guaranteed every 10 draws; the cumulative probability of obtaining an Epic(purple) item reaches 38% within 30 draws, with a guaranteed reward after 60 draws; whilst the base probability of obtaining a Legendary (gold) item is approximately 0.7%, with a cumulative probability of 6.3% after 50 draws and 25% after 100 draws, and a guaranteed reward after 200 draws [2]. The guaranteed reward mechanism which ensures a reward is awarded after a certain number of unsuccessful draws.

Previous research on loot boxes has primarily focused on their psychological effects. Experimental evidence suggests that rarer rewards within loot boxes trigger stronger feelings of excitement, reward responses and the urge to continue opening them. Other studies have examined the issue of probability disclosure and found that players'purchasing behaviour is influenced by information regarding loot box probabilities [3]. Furthermore, when loot box items are available on a secondary market, rare virtual items may acquire considerable monetary value. For example, a study on Counter-Strike noted that extremely rare weapon skins can fetch resale prices of several thousand US dollars on the secondary market. [4].

However, most of the existing literature focuses solely on the psychological drivers of loot box opening or the macroeconomic effects on the secondary market. Few studies have systematically examined how the specific probabilistic parameters of loot boxes including base drop rates and guaranteed drop thresholds directly shape secondary market prices and, in turn, influence players' purchasing and trading decisions.

This study therefore takes Identity V as a case study to examine how loot box probabilities influence secondary market prices and player decision-making. This paper will analyse the relationship between the publicly disclosed probability structure (including guaranteed drop mechanisms) and the valuation of rare skins in the player-to-player trading market, as well as how these prices influence players' choices whether to open loot boxes directly or to acquire items via secondary market platforms.

2. Method

2.1. Data sources

The secondary data used in this study was primarily sourced from two publicly available online data channels.

Firstly, specialist websites dedicated to game probability statistics. These websites aggregate and publish the 'core probabilities' of a game's loot boxes that is, the actual drop rates of items and parameters relating to guaranteed drop mechanisms (such as the aforementioned 0.7 per cent and 200-attempt guarantee) using large-scale public samples from player communities or data mining techniques. Compared with a single official document, this large-scale aggregated data provides a more accurate reflection of the actual drop rates experienced by players [2].

Secondly, mainstream third-party in-game item trading platforms (such as the Steam Community Market). These platforms provide real-time trading prices, historical trading volumes and 'ownership rates' (i.e. the proportion of players in the market who own that item) for specific legendary items. Ownership rate data directly reflects the actual scarcity of that item within the player base [4].

2.2. Detailed account of the loot box system and drop probabilities

The game runs under a variable-ratio reinforcement rule; every single draw works as an independent event. According to official information, the probability of getting one Legendary item from a single

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draw is set at p = 0.7%.

In order to check whether the published probability data are reliable, this paper carries out mathematical verification through reverse calculation before building further models; the formula used to work out the cumulative probability P of receiving at least one Legendary item over several draws is shown below.

Under the actual game rule, there is a built-in condition that the cumulative probability of drawing a Legendary item reaches P = 50% within n = 100 draws [5]. When these numbers are put into the verification formula, 0.5 = 1-(1-p)^100 can be obtained; after rearranging this equation to solve for 1-p = 0.50, the theoretical value of p is calculated to be around 0.006908, which is very close to the official drop rate of 0.7%. This cross check proves that the probability system inside the game follows the standard binomial distribution, and on this basis the paper continues to complete the remaining mathematical calculations.

Besides this probability rule, the game also includes a protection mechanism to stop players from suffering extremely bad luck; this rule sets a hard upper limit on the total number of draws; if a player still has not got any Legendary skin after opening 200 boxes one after another, the 200th box will definitely contain a Legendary item [6].

2.3. Models

In this part of the study, a two-part mathematical model is built to measure how much money players may spend trying to obtain their target skins and to analyse the decisions players make during this process. Cost model: The main cost model applied in this paper is expressed through a linear equation. The formula for the expected cost $E(C)$ is:

$$\mathrm{E(C)} = 9.6 \times \mathrm{E(N)} \tag{1}$$

where E(N) is the expected number of draws required to obtain a legendary item . Based on the binomial distribution and taking into account the guaranteed reward limit after 200 draws, the expected number of draws is calculated to be approximately E(N) ≈¥ 142.86 [7]. Therefore, the expected cost of unlocking this item is calculated as:

$$\mathrm{E(C)} = 9.6 \times 142.86 \approx ¥\,1{,}371.46 \tag{2}$$

Conversely, the maximum cost (worst-case scenario) occurs when the guaranteed reward mechanism is triggered precisely on the 200th draw, calculated as:

$$\mathrm{Cmax} = 200 \times 9.6 = ¥1{,}920 \tag{3}$$

This cost framework enables us to establish a key comparative variable: namely, the significant discrepancy between the internal cost of acquiring the item and the secondary market price at which it is traded [8]. This is the key determinant of 'players' choices at different price points and levels of scarcity'.

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3. Result and discussion

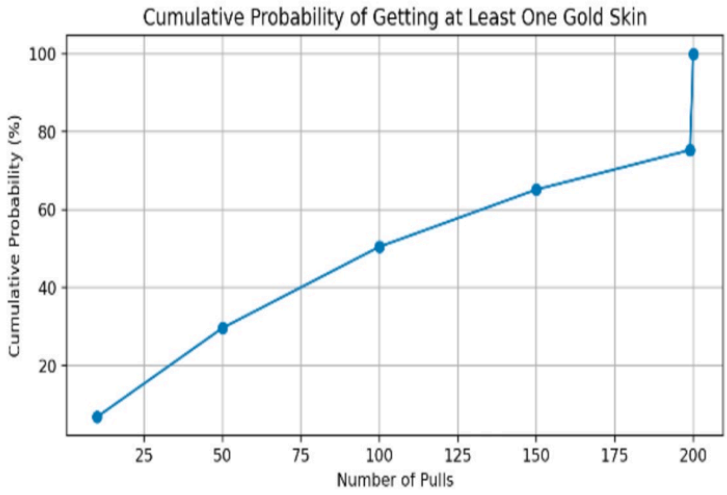


Figure 1. Cumulative probability of getting at least one gold skin (picture credit: original)

Table 1. Impact of loot box probability on scarcity, secondary market price and player choice

Probability	Scarcity	Type of Legendary	Second-hand prices	Player preferences
Buy directly	Low	Permanent Shop	¥120–20	Buy directly
0.7%	Medium	Limited-time	¥200–400	Extract
0.7% + Limited time offer	High	P-Link	¥350–800	second-hand items
0.3%	Very High	Rare and out of print	¥3,000–7,000	second-hand items

Figure 1 provides the Cumulative Probability of Getting at Least One Gold Skin. In addition, Table 1 provides the Impact of Loot Box Probability on Scarcity, Secondary Market Price and Player Choice. In the Identity V loot box (Essence/Treasure) system, the probability of obtaining high-rarity items (such as golden skins) is not fixed; rather, the cumulative probability of obtaining them increases as the number of draws rises. Specifically, according to the official guaranteed drop rules, the cumulative probability of obtaining a gold item after 10, 50, 100, 150 and 199 draws is approximately 6.78 %, 29.59 %, 50.39 %, 65.03% and 75.29% respectively; and upon the 200th draw, as the guaranteed drop mechanism is triggered, the cumulative probability reaches 100 per cent. This probability structure indicates that the more draws a player makes, the greater the certainty of eventually obtaining a rare item, thereby balancing, to some extent, the frustration caused by randomness.

On second-hand market, the lower the ownership rate, the higher the selling price. The scarcer the skin, the fewer people own it, so the price at which it is sold on the second-hand market will also be higher [8].

This study cross-references existing mathematical models with market data. According to calculations based on the cost model, the expected cost for a player to obtain a Legendary (Gold) item is ￥1,371.46, with a maximum guaranteed cost of ￥1,920. However, according to actual data from the secondary market, prices for different categories of items show severe polarisation: for

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ordinary permanent items sold directly (¥120–200), the market price is far lower than the expected cost of ¥1,371.46 paid by players; whereas for top-tier, discontinued skins (¥3,000–7,000+), the market price far exceeds the expected cost of opening a loot box [4].

This study makes comparisons between existing mathematical models and real-world market data. Based on the cost model used in this paper, a player would need to spend an expected amount of ¥1,371.46 to get one Legendary (Gold) item, and the largest possible cost under the guaranteed rule is ¥1,920. Meanwhile, real data collected from the secondary market shows that the prices of different item groups vary hugely; ordinary permanent items that remain on sale are traded at around ¥120-200, which is much lower than the expected cost of ¥1,371.46 for players to obtain the same item through loot boxes, while top-tier skins that are no longer released can reach ¥3,000-7,000 or even higher on this market.

There is a clear gap between the expected draw cost and the actual ownership rate as well as the trading price recorded on second-hand trading platforms; this gap points to an unusual pattern of player behaviour inside the game market.

This part of the paper looks into one central question: how probability information shapes the choices made by players; the results suggest that players tend to follow their own personal judgement about probabilities, instead of carrying out a full rational calculation on expected costs. This finding matches the results from earlier experimental research, which states that the design of loot boxes can make players overestimate their chance of winning rewards, and it raises their willingness to spend money on in-game draws [9].

From the data listed above, it can be observed that one basic pattern behind players' decisions; when second-hand prices stay well above the money needed for individual draws, players are more willing to open loot boxes by themselves, but for rare legendary skins that have been permanently removed from the game, players prefer buying the target item directly from the secondary market [10].

This kind of mindset, in which players chase a very large reward through gambling-style draws, can be explained with prospect theory [11]. When top-tier skins with extremely high market prices (¥3,000-7,000+) are available on the secondary market, the single-draw price (¥9.6) and the guaranteed maximum cost (¥1,920) look relatively cheap to players; this perception greatly encourages players to take risks, so they are willing to bet on the tiny winning chance (0.7 per cent) for a huge reward. Even though the average expected cost is calculated to be as high as ¥1,371.46, players still believe that they will make a profit once they finally obtain the skin, and this belief drives them to keep spending large amounts of money on loot boxes.

4. Conclusion

This study initially set out to investigate how players can obtain their favourite in-game skins at a lower cost, and to analyse the relationship between gacha probabilities and second-hand market prices. Through probability analysis, expected cost calculations and comparisons of second-hand market prices, this study integrates gacha mechanisms with economic concepts such as scarcity, supply and demand, and opportunity cost. The findings indicate that gold skins have a base probability of only 0.7 %, exposing players to a high degree of uncertainty, whilst the '200-draw guarantee' mechanism increases the certainty of ultimately obtaining a gold skin. In the second-hand market, there are marked price differences between gold skins: ordinary permanent gold skins cost approximately 120–200 yuan, whilst rare, popular collaboration or discontinued skins can fetch several thousand yuan. This suggests that skin prices are influenced not only by gacha probabilities and scarcity, but also by player preferences, IP value and market demand. Consequently, players

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choose between gacha draws and direct purchases based on their own assessments of probability, price and risk. The limitations of this study lie in the limited scale of the secondary market data and the absence of surveys on players' actual decision-making processes. In future, larger-scale market data could be collected and combined with questionnaire surveys and linear regression models to examine the relationship between probability, rarity and secondary market prices more systematically.

References

[1] Nielsen, R. K. L., & Grabarczyk, P. (2019). Are loot boxes gambling? Random reward mechanisms in video games. *Transactions of the Digital Games Research Association, 4*(3), 171-207. https://doi.org/10.26503/todigra.v4i3.104

[2] Identity V Wiki. (2025). Essence probability. *Bilibili Game Wiki*. https://wiki.biligame.com/dwrg/%E7%B2%BE%E5%8D%8E%E6%A6%82%E7%8E%87

[3] Xiao, L. Y., Fraser, T. C., & Newall, P. W. S. (2023). Opening Pandora's loot box: Weak links between gambling and loot box expenditure in China, and player opinions on probability disclosures and pity-timers. *Journal of Gambling Studies, 39*(2), 645-668. https://doi.org/10.1007/s10899-022-10148-0

[4] Macey, J., & Hamari, J. (2019). eSports, skins and loot boxes: Participants, practices and problematic behaviour associated with emergent forms of gambling. *New Media & Society, 21*(1), 20-41. https://doi.org/10.1177/1461444818786216

[5] NetEase Games. (2025). Identity V treasure pavilion. *NetEase Treasure Pavilion*. https://id5.cbg.163.com/

[6] Wang, J. K. (2024). Corrections to the two-sided probability and hypothesis test statistics on binomial distributions. *Acta Agronomica Sinica, 50*(6), 1361-1372. https://doi.org/10.3724/SP.J.1006.2024.33057

[7] Kang, J. W., & Kim, H. N. (2022). A study on the probability type gacha system and the usefulness of the pity system. *Proceedings of the Korean Society of Computer Information Conference, 30*(2), 209-211.

[8] Ahlgren, J. (2014). The probability distribution for draws until first success without replacement. arXiv preprint, arXiv:1404.1161.

[9] Dobrynskaya, V., & Strelnikov, V. (2025). Videogame attributes as alternative investments. *The Quarterly Journal of Finance, 15*(4), 2640001. https://doi.org/10.1142/S201013922640001X

[10] Cordes, S., Dertwinkel-Kalt, M., & Werner, T. (2024). What drives demand for loot boxes? An experimental study. *Journal of Economic Behavior & Organization, 228*, 106755. https://doi.org/10.1016/j.jebo.2024.106755

[11] Sunstein, C. R. (2009). *Worst-case scenarios*. Harvard University Press. https://doi.org/10.4159/9780674033535