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Exploring the Sustainable Development of Web3 Game Token Economy

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Abstract: With the popularity of Play-to-Earn (P2E) games, in-game token economies have become the foundation of the financial structure of virtual worlds. More and more players are investing in digital assets, promoting long-term economic growth. This paper delves into the key factors for the sustainability of the P2E game token economy: the investment value of tokens and external incentives. When tokens are no longer profitable, user churn rates rise sharply, which is critical to the continued development of P2E games. External factors also significantly impact token prices, which affects the stability and sustainability of the entire economic system. In response to these challenges, this paper proposes a series of strategies to enhance token stability, including adjustments to game design, improvements to player incentive mechanisms, and the formulation of relevant policies and regulations. The conclusions of this study aim to provide valuable insights and guidance to game designers, investors, and players to promote the healthy development of Web3 game token economic systems.

Keywords: Play-to-Earn (P2E); token economic system; sustainability; number of active users; Web3

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1. Introduction

With the advancement of the digital age, blockchain technology has had a significant impact on the field of game economy [1]. Web3 games have reshaped the traditional economic model with their decentralized, transparent, and reliable characteristics [2]. The integration of blockchain technology offers games a decentralized, transparent, and secure economic system. It effectively prevents fraud and enhances transaction transparency and trust through accurate records in distributed ledgers and the automated rules of smart contracts [3]. The application of NFTs verifies the authenticity of assets and gives real ownership and trading freedom to in-game items [4]. The rise of Play-to-Earn (P2E) games has intensified this shift by closely linking game activities with the real economy. Players can now generate actual value within the game, blurring the lines between virtual entertainment and the real economy [4]. In these games, players earn tokens by participating in activities, which can not only be used to purchase in-game items, but also be exchanged for legal currency [5]. Therefore, the emergence of the Web3 game token economy system has significantly changed the value concept of the gaming experience [6].

However, the sustainability of token economic systems in P2E games faces significant challenges. This paper aims to explore the core factors affecting token stability in P2E games and propose measures to enhance their long-term sustainability. This research is crucial as the sustainability of P2E games directly impacts player engagement and the health of the game ecosystem.

We will use the following research methods. First, we will analyze the price formation mechanisms of game tokens, focusing on investment properties and inflation. By examining user activity and token price trends in *Alien Worlds* and *Axie Infinity*, we will explore how token investment properties influence user engagement. Next, we will discuss the short-term impact of external stimuli like market sentiment on token prices. Finally, we will propose measures to improve token stability, including currency recovery mechanisms, introducing interest rates and gaming banks, setting issuance caps, and new token lock-up periods.

Our research will identify the main causes of token instability and provide improvement measures. This will help game developers and economists better understand and manage token economic systems in P2E games, promoting their healthy and sustainable development.

In this paper, *Alien Worlds* and *Axie Infinity* were selected as the primary case studies due to their significant representativeness and influence in the P2E gaming sector. *Axie Infinity*, as an early successful P2E game, provides important empirical data on the relationship between token value and user behavior through its token economic model and player interaction mechanisms. *Alien Worlds*, with its unique economic design and cross-chain operations, demonstrates the application and challenges of token economics in different gaming environments. Both games have experienced significant fluctuations in token economic stability, offering valuable insights for analyzing the impact of token value volatility on user activity.

By studying these two games, we can explore how the instability of token economic systems affects player engagement and retention, thereby validating the crucial role of token economic stability in P2E games. Additionally, this paper briefly discusses other representative games, such as *The Sandbox* and *Decentraland*, to enhance the generalizability of the conclusions and provide a comprehensive perspective on the sustainability of token economics.

2. Token Economy System and Sustainability Challenges

2.1. Price Formation of Game Tokens

In economics, supply and demand are key factors in price formation [7]. Market equilibrium theory explains how markets reach equilibrium by analyzing the intersection of supply and demand curves. The demand curve shows how the amount of goods or services consumers demand changes as the price changes, while the supply curve depicts the amount of goods or services producers are willing to provide as the price changes [8]. Supply and demand determine the direction of prices: when demand rises or supply decreases, prices tend to rise; when demand falls or supply increases, prices generally fall [9]. The intersection of the two curves is the market equilibrium point, marking the formation of equilibrium price and trading volume. At this point, the buyer's willingness to buy is consistent with the seller's willingness to sell. The game token market also follows these principles, because token prices are also affected by player demand and developers' token supply strategies.

Market supply and demand are key factors in determining prices. In-game economic activities, including task completion, asset trading, and token mining, directly affect the supply and demand of tokens [10]. The growth of the player base will increase the demand for tokens, which may lead to an increase in the value of tokens. At the same time, the listing of tokens on major exchanges increases their availability and improves the overall liquidity of the market, which in turn affects prices.

Investor sentiment and market psychology have a significant impact on token price fluctuations [11]. The herd effect often drives investors to imitate the behavior of others, which may lead to drastic fluctuations in token prices. Investors' emotions and confidence also influence their investment decisions. Optimism may prompt investors to increase token purchases, thereby pushing up prices, while pessimism may trigger selling, causing prices to fall. Market news, technological developments, regulatory changes, and rumors

on social media can all be factors that affect price fluctuations [12]. For example, news that a P2E token is listed on a major exchange may trigger a short-term price increase.

Global economic trends and macroeconomic events have a significant impact on token prices. For example, when economic uncertainty rises, investors may use cryptocurrencies as safe-haven assets, pushing up their prices [13].

In the price formation mechanism, the interactions between trading platforms, market liquidity, and regulatory policies all play a key role. Different trading platforms may have different prices due to differences in user base, transaction fees, and liquidity levels. Fluctuations in market liquidity, such as a sharp increase or decrease in trading volume, will directly affect prices [14]. At the same time, adjustments to regulatory policies may cause market uncertainty, which in turn affects prices.

Overall, the formation and transmission of P2E token prices is a complex and multi-layered process, which is affected by a combination of factors [15]. A comprehensive analysis of these factors and their interactions can help us gain in-depth insights into market dynamics. This can not only provide strategic guidance for players and developers, but also assist regulators in ensuring market fairness and transparency.

2.2. Token Investment Properties

In the P2E gaming space, games based on Web3 technology have attracted attention for their transparent and decentralized environments. These games provide players with actual asset ownership and reward players for their investment with substantial returns. Players can earn a stable cryptocurrency income by participating in game activities, which usually involves staking, earning game currency, or creating tradable NFTs (non-fungible tokens) [16–18]. This model is closely linked to economic incentives and becomes the main driving force for player participation, which is in stark contrast to the traditional free-to-play model. In traditional game models, players usually do not receive direct financial rewards for participating in games. Web3 games combine blockchain technology to open up a new in-game economy and business model [19]. Multiple studies have highlighted this trend, pointing out that players are increasingly inclined to participate in games that provide economic incentives.

The virtual economy of P2E games promotes active participation by players by providing valuable virtual assets. In this system, the scarcity of tokens is a key factor in determining their value [20]. Take Bitcoin as an example. The total supply of this cryptocurrency is capped, which gives it scarcity. Other types of tokens may use different supply mechanisms. Generally, tokens with limited supply or that are gradually released according to specific rules are more likely to be considered valuable assets by investors. The scarcity of tokens helps them maintain price stability in the market and helps maintain their value in the long run.

Blockchain technology plays a key role in ensuring the scarcity of game tokens and digital collectibles [21]. Take *Alien Worlds*, for example, which creates scarcity of digital assets through mining and resource interaction on virtual planets. Players act as miners, obtain unique non-fungible tokens (NFTs) through mining, and interact with others to compete for scarce resources [22]. Although *Alien Worlds* partially ensures the scarcity of TLM by limiting the total supply and daily mining output of the in-game token TLM, as well as meeting players' demand for TLM to purchase, trade, and upgrade, challenges still exist. The problem of oversupply and insufficient in-game demand may affect the value of TLM.

Axie Infinity creates scarcity of digital assets through its unique mechanism of collecting, breeding, and trading virtual creatures [23]. Each Axie in the game has unique characteristics and genetic attributes, making it a one-of-a-kind digital asset. By design, *Axie Infinity* increases the scarcity of tokens by limiting the total supply of Axies, meeting the continuous demand in the game, and giving AXS token holders the right to participate in governance. However, challenges such as high barriers to entry and economic fluctua-

tions in the game still exist, which may limit the entry of new players. At the same time, the breeding and trading mechanisms of Axies may also affect their scarcity.

Similarly, in *The Sandbox*, players create and trade virtual assets and land using SAND tokens, with the total supply of SAND being capped to preserve its value. The scarcity of virtual land and the exclusivity of player-created content further enhance the value of SAND tokens. *Decentraland* operates on a similar principle, where MANA tokens are used to buy, develop, and trade virtual real estate. The limited availability of prime virtual locations and the demand for unique experiences ensure the scarcity of MANA. Despite these mechanisms, all games face challenges such as market volatility and fluctuating demand, which can impact the stability and perceived value of their respective tokens.

Secondly, the liquidity of a token plays a crucial role in its price and market liquidity [24]. Liquidity describes the ability of a token to be freely bought and sold in the market. If a token is easy to transfer and trade, market participants can easily buy and sell it at different price levels, which helps to form an active market. In addition, the liquidity of a token also has an impact on price volatility. High liquidity in the market helps to mitigate sharp price fluctuations because the presence of a large number of buyers and sellers can balance out extreme price changes.

Finally, investors usually focus on the expected returns of tokens. Expected returns cover the capital appreciation that investors may receive after purchasing tokens, as well as potential dividends or profit sharing. Factors that affect investors' expected returns include the feasibility of the token project, future development prospects, and whether token holders can actually benefit from the success of the project. Therefore, the expected profitability of a token has a significant impact on its market price. High expected returns often attract more investors' interest [25], thereby driving up token prices.

The data from *Axie Infinity* and *Alien Worlds* reveal a phenomenon: there is a direct correlation between token valuation and the number of active users.

In the *Axie Infinity* game, user activity has increased significantly as the price of the AXS token has risen, which is consistent with the "wealth effect" in economics. According to economic principles, participants who are more financially well-off tend to show higher levels of economic activity. Conversely, a drop in the value of cryptocurrencies may inhibit players' participation as they worry about potential financial losses. The daily active user trends of *Axie Infinity* and the price trend of the AXS token are shown in Figures 1 and 2, respectively.

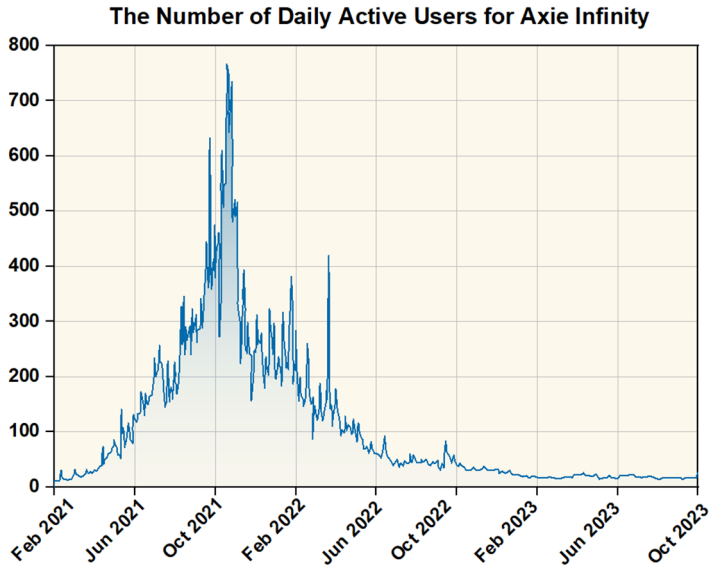

Figure 1. The number of daily active users for *Axie Infinity*. Source: DappRadar. https://dappradar.com/dapp/axie-infinity?range-ds=30d&range-ha=all (accessed on 24 April 2024).

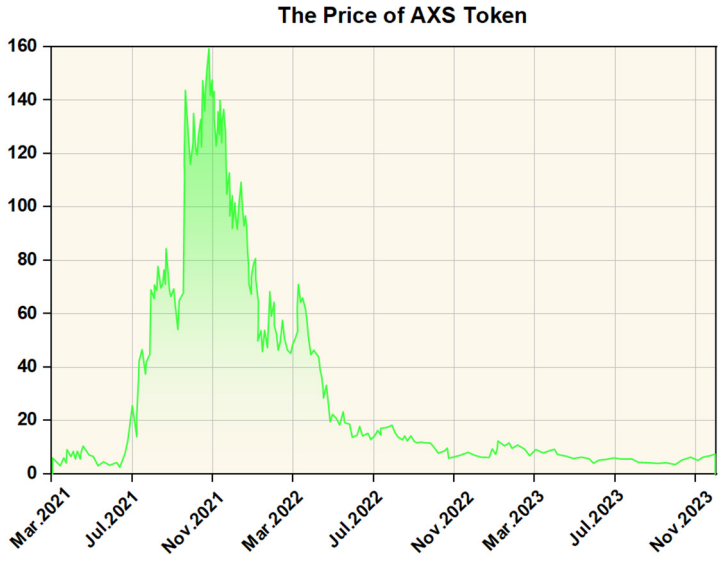

Figure 2. The price of AXS token for *Axie Infinity*. Source: DappRadar. https://dappradar.com/token/axie-infinity?range-lhr=all (accessed on 24 April 2024).

Alien Worlds also shows a similar trend. The fluctuation of the token (TLM) price is closely related to the number of active users. When the price rises, users are more motivated to participate in game activities such as mining; when the price fluctuation makes it difficult for users to obtain the expected benefits from the game, the user churn will increase significantly. The trend in the number of daily active users of *Alien Worlds* and the price trend of the TLM token are shown in Figures 3 and 4, respectively.

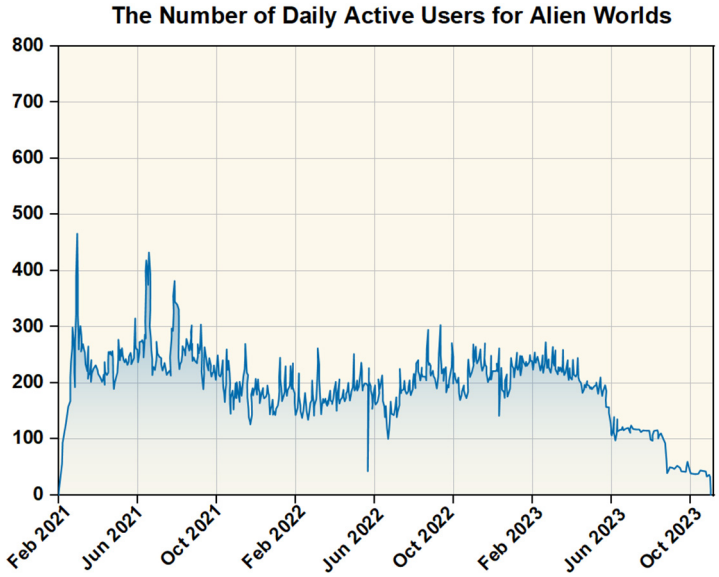

Figure 3. The number of daily active users for *Alien Worlds*. Source: DappRadar. https://dappradar.com/dapp/alien-worlds?range-ha=all (accessed on 24 April 2024).

By comparing the data from 2021, we can observe that both the daily active users (UAW) and TLM token price of *Alien Worlds* have experienced significant growth. However, in 2022, both indicators showed a clear downward trend. This upward and downward trend shows a clear correlation. The fluctuations in the prices of UAW and TLM tokens in *Alien Worlds* are closely linked to factors such as game content, gameplay, and economic models. The continuous fluctuations in token prices are directly related to users' mining and other behaviors of earning tokens. When the price of TLM tokens no longer has the "yield" attribute that attracts users, the rate of user churn will increase sharply.

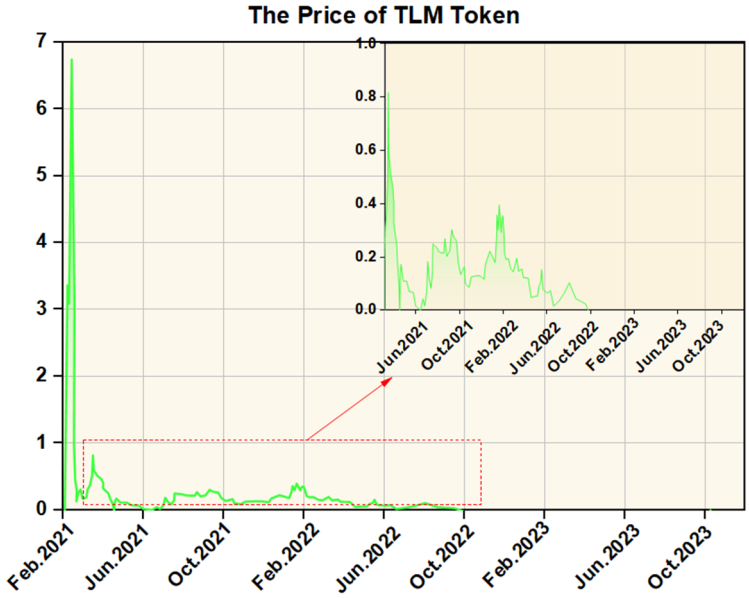

Figure 4. The price of TLM token for *Alien Worlds*. Source: DappRadar. https://dappradar.com/token/alien-worlds?range-lhr=all (accessed on 24 April 2024).

Observing the changes in user activity (UAW) and token price trends for the first two games, we can find that they generally show a trend from high to low. Although there have been increases over time, most of these increases were driven by external stimuli or intervention by service providers. However, over time, the effectiveness of these interventions or the effectiveness of the stimuli gradually weakened, causing the game to return to its initial downward trend. As the price of the game token fell, the "earning" attribute of the token no longer existed, which slowed down the rate at which new players joined, and old players began to gradually exit the game.

To assess the generalizability of this observation, we can examine other representative P2E games. For instance, in *The Sandbox*, players earn SAND tokens by purchasing and developing virtual land, as well as creating and trading virtual assets. Data indicate that when the value of SAND tokens increases, the daily active user count for *The Sandbox* also rises. This is because players' expectations of returns on virtual land and assets improve, leading to higher engagement. Conversely, when the token value declines, user engagement drops significantly, as players perceive the returns on their investments as unstable, resulting in decreased participation or even game abandonment.

Similarly, in *Decentraland*, players earn MANA tokens through activities such as purchasing and developing virtual real estate, leasing land, and hosting virtual exhibitions and events. Long-term data analysis reveals that an increase in MANA token value correlates with a rise in daily active users. This correlation is due to improved expectations of returns on virtual real estate and activities, which boosts engagement. Conversely, when MANA token value falls, user activity decreases as players fail to achieve anticipated economic returns, leading to reduced game time or withdrawal from the game.

These examples show that user churn is mainly due to the instability of token economics. Players who feel they cannot achieve the expected economic returns tend to quit the game, which in turn leads to a decrease in social interaction and community vitality in P2E games. The volatility of token prices is not only linked to the number of players, but also affects their enthusiasm for participation. Therefore, the investment potential of tokens is the key to the continued appeal of P2E games.

However, as shown in the figures, the fluctuations in daily user activity do not entirely align with the variations in token value. This indicates that, aside from the impact of token value on daily activity, other underlying factors are also at play. As we will discuss in Section 2.4, external stimuli such as changes in market sentiment can directly influence user activity in the short term, which in turn affects token value fluctuations.

2.3. Inflation

In the field of P2E games, the investment value of tokens is seen as the key to ensuring the long-term sustainability of games [26]. Although the investment properties of tokens are extremely important to maintain the stability of the game ecosystem, the token economy still faces some fundamental challenges, one of which is inflation. As the main factor in the imbalance of the token economy, inflation has the potential to have a significant impact on the stability and sustainability of the game ecosystem.

From a macroeconomic and microeconomic perspective, the causes of inflation are complex and diverse. At the macroeconomic level, it is often related to excessive growth in the money supply [27]. If token issuers increase the issuance of tokens without restraint, so that the supply greatly exceeds the actual market demand, it may trigger a decline in the value of the currency and inflation. At the same time, demand-driven inflation is also likely to occur. When players' demand for certain tokens surges and the supply cannot keep up, the token price will rise, which may also trigger inflation.

In the field of P2E games, the problem of inflation may be particularly prominent, because the supply and demand of tokens in the game are jointly affected by game design, player behavior, and market dynamics [28]. If the supply of tokens in the game cannot keep up with the demand of players, or the market sees sharp fluctuations in token prices, the risk of inflation will increase, which will not only threaten the sustainability of the game, but also affect the enthusiasm of players to participate.

We analyzed the price fluctuations of tokens in the blockchain games *Axie Infinity* and *Alien Worlds* based on factors such as supply and demand and inflation. Both games contain tokens and NFTs, so we assumed that their economic models are comparable [29].

In the early stages of a game, high demand for unique NFTs (such as Axies in *Axie Infinity* or Land in *Alien Worlds*) will often lead to an increase in the price of tokens (such as AXS or TLM) due to the relatively limited supply of these NFTs [30]. Users are willing to pay high fees to obtain these scarce resources (as shown in Figure 5).

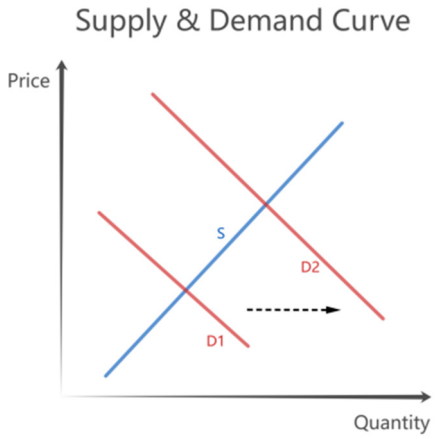

Figure 5. Increased demand leads to higher prices. Source: https://socialsci.libretexts.org/Bookshelves/Economics/Principles_of_Economics_(LibreTexts)/03:_Demand_and_Supply/3.3:_Demand_Supply_and_Equilibrium (accessed on 24 April 2024).

As the game develops, if too much token is produced (e.g., AXS or TLM obtained through in-game tasks, mining, etc.), and this additional supply cannot be fully consumed by actual game demand, it will lead to oversupply, which will cause inflation. Inflation is a

phenomenon in which the value of a currency decreases due to an increase in the money supply.

When the purchasing power of tokens decreases, users may choose to sell their tokens or non-fungible tokens (NFTs) to minimize losses [31,32]. This behavior may lead to an increase in market supply in the short term, further depressing token prices. If this trend continues, it may trigger a negative cycle: as the value of tokens decreases, more users choose to sell, which in turn causes the value of tokens to decline further (as shown in Figure 6).

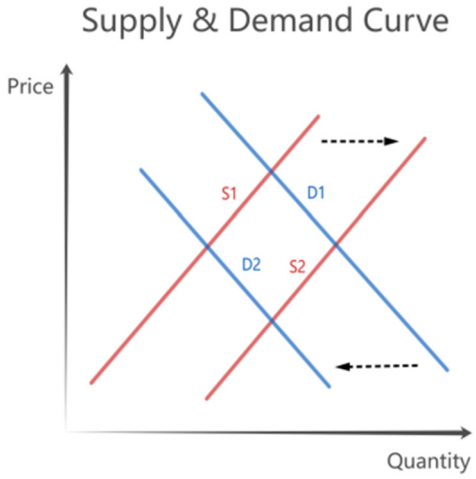

Figure 6. Falling demand and rising supply cause prices to fall further. Source: https://socialsci.libretexts.org/Bookshelves/Economics/Principles_of_Economics_(LibreTexts)/03:_Demand_and_Supply/3.3:_Demand_Supply_and_Equilibrium (accessed on 24 April 2024).

In Web3 games, the economy is usually open, meaning players can buy and sell in-game assets on markets outside the game [33,34]. This openness makes the in-game economy closely tied to the real-world economy. Therefore, the price of a token or NFT is affected not only by in-game supply and demand, but also by external market sentiment, macroeconomic conditions, and other factors.

By analyzing supply, demand, and inflation, we can gain more insight into the price fluctuations of tokens in *Axie Infinity* and *Alien Worlds*. In the beginning, the value of tokens may rise due to the relatively limited supply. However, over time, if the production of tokens exceeds the actual demand, it may lead to inflation, which will cause the value of tokens to fall. In addition, the collective behavior of players, especially the large-scale sale of tokens, and external market factors may also have a significant impact on the price of tokens.

In order to deal with the economic imbalance caused by inflation, some policy measures may be needed to ease inflationary pressure [35]. One potential policy option is to control the money supply. The currency issuing agency can effectively control the money supply by setting a maximum supply of money or implementing a currency issuance ceiling to ensure that it matches economic growth, thereby avoiding the occurrence of inflation [36]. In addition, strengthening market supervision and cracking down on market manipulation are also crucial to maintaining market order and alleviating inflationary pressure.

2.4. External Stimuli

The fluctuation of token prices is affected by many factors. Market supply and demand, macroeconomic factors, and project policy adjustments jointly determine the trend of token prices [37]. In the field of P2E games, the rise in token value is not only closely related to the internal mechanism of the game, but external factors also play a vital role. Taking popular games such as *Axie Infinity* and *Alien Worlds* as examples, we can observe how market sentiment, the overall trend of the cryptocurrency market, and media coverage

work together to affect the value of these game tokens. The influence of these external factors on token prices cannot be ignored.

In 2021, the economic recession and rising unemployment caused by the COVID-19 pandemic brought challenges to the Philippines. *Axie Infinity*'s game model provides Filipino players with new ways to make money, attracting a large number of players to participate. By August 2021, the Philippines became the country with the largest number of daily active users of *Axie Infinity*, accounting for as much as 40.53% [38], many of whom are students who see the game as a source of income and challenge [39]. During the same period, the cryptocurrency market as a whole rose, and the prices of mainstream currencies such as Bitcoin and Ethereum hit new highs [40]. The surge in market interest in cryptocurrencies and blockchain games has driven positive market sentiment, which has also had a positive impact on the value of AXS tokens. As a result, *Axie Infinity*'s token (AXS) experienced significant price increases in 2021.

External stimuli played a significant role in the price fluctuations of the *Alien Worlds* token (TLM). Between September and November 2021, the launch of new content and features within the *Alien Worlds* game successfully attracted more player attention and participation. The announcement of new partnerships, coupled with extensive discussions on social media platforms, further pushed up the market price of the TLM token. According to DappRadar, the value of the TLM token increased by a staggering 44 times in April 2021. This market reaction highlights the profound impact of external factors on the value of P2E game tokens.

To further demonstrate this, we examine the price charts and social media activity for *Axie Infinity* and *Alien Worlds*. By comparing the price fluctuations of AXS and TLM to key external events, such as announcements of major partners, coverage in the mainstream media, and overall movements in the cryptocurrency market, we can see a connection between them. As shown in Figures 7 and 8, the price fluctuations of AXS and TLM at specific points in time are closely correlated with these external events. These charts clearly show that when games are affected by positive external factors, the token prices tend to rise.

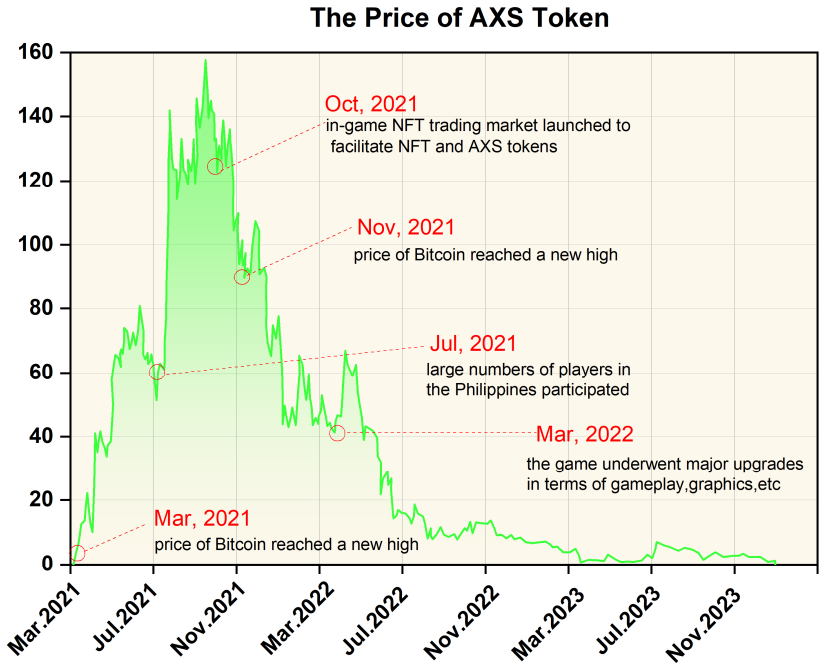

Figure 7. Correspondence between price changes of AXS at specific time points and external events.

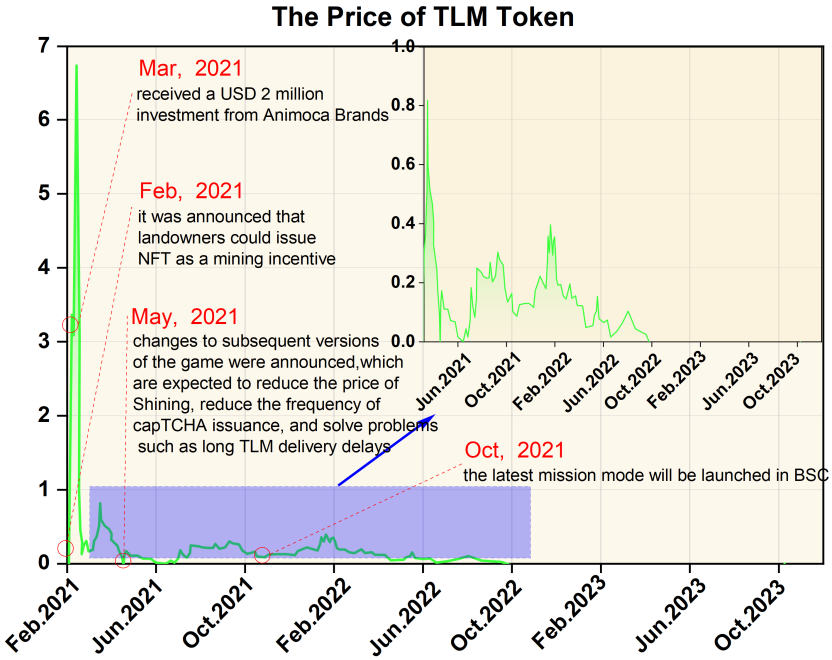

Figure 8. Correspondence between price changes of TLM at specific time points and external events.

The Sandbox and *Decentraland* also exhibit this characteristic, where positive external stimuli can lead to short-term increases in token prices. For instance, when favorable market sentiment or major updates are announced, both *The Sandbox* and *Decentraland* often experience a surge in SAND and MANA token prices. This is driven by heightened user confidence and excitement about future prospects. During these periods, players and investors may rush to acquire tokens, anticipating future value increases due to new features or partnerships.

Token price fluctuations have a significant impact on user psychology and behavior [41]. When prices rise, users may be overly optimistic and frequently trade and hold; when prices fall, they may turn pessimistic and adopt a sell-off or wait-and-see attitude. Such psychological fluctuations may weaken users' long-term participation and loyalty.

Although external incentives and service provider intervention can attract users in the short term, more comprehensive and innovative strategies are needed to maintain the vitality of games in the long term. Regularly launching new activities, cross-sector cooperation, and enhancing community participation are all feasible solutions. However, the effectiveness of these strategies needs to be constantly evaluated and adjusted in actual operations. This highlights the complexity of the game ecosystem and the multifaceted needs to ensure the sustainability of P2E games.

3. Measures to Improve Token Stability

3.1. Regulation from the Perspective of Game Design

3.1.1. Currency Recovery Mechanism

In Web3 games, the currency recycling mechanism is crucial for controlling token supply, stabilizing value, and shaping player behavior and experience. Through the setting of consumption points such as skill upgrades, purchasing virtual goods, and participating in specific activities, the game encourages players to actively participate and use tokens. This leads to a decrease in the number of tokens in circulation, which is expected to stabilize the value of tokens and increase the actual value of tokens and player trust through frequent use.

However, the currency recycling mechanism may also cause dissatisfaction, especially for players who tend to store tokens in the hope of appreciation. To meet the needs and preferences of different players, developers should provide diversified consumption options. These are essential for addressing varying player preferences and enhancing

engagement. For example, in *Axie Infinity*, players can use tokens to purchase and nurture Axie characters, upgrade their skills, and acquire in-game items, allowing them to invest in different aspects of gameplay. Similarly, in *The Sandbox*, players spend tokens on tools and resources to create custom content, such as NFTs or virtual assets, which can be traded or used within the game. This caters to those interested in creative and entrepreneurial activities.

In *Decentraland*, tokens are used for buying virtual land and real estate, which players can develop and showcase. This not only provides a consumption option but also adds value to the game environment, encouraging long-term investment in virtual properties. Additionally, tokens can be spent on participating in virtual events, exhibitions, and social gatherings, enhancing the social and interactive aspects of the game.

Alien Worlds offers another dimension by allowing players to use tokens for mining, land leasing, and engaging in various tasks and challenges. These activities provide multiple ways to utilize tokens and interact with the game's economy. By integrating these diverse consumption options, developers can cater to different player preferences, from investment and collection to active participation and creative contribution. This approach not only addresses the needs of players who may prefer to store tokens for potential appreciation but also promotes ongoing engagement, ultimately enhancing the game's sustainability and attractiveness.

3.1.2. Introducing Interest Rates and Gaming Banks

In Web3 games, players can deposit tokens into game banks and earn interest through established interest rates. This mechanism not only encourages players to hold tokens long-term but also integrates these tokens into the game's economic system. Game banks can lend these deposited tokens to other players or use them in various in-game financial activities, thus increasing token circulation and usage. This is similar to traditional banking systems, where deposited funds are reused to enhance overall economic activity.

Moreover, the deposit, withdrawal, and loan services provided by game banks offer players more financial options. These diversified financial tools and services attract players to manage their assets more rationally, rather than merely storing tokens without using them. By setting reasonable interest rates, players are more inclined to deposit their tokens to earn returns, while also preventing excessive token devaluation or inflation, thereby maintaining token value stability.

In summary, by introducing interest rate mechanisms and game banks, Web3 games can encourage players to participate more actively in the game economy, ensure token liquidity and usage, and enhance token stability and the sustainability of the game's economic system.

3.1.3. Set a Cap on Total Issuance and Release in Phases

In the P2E mechanism of Web3 games, setting a total limit on token issuance and issuing tokens in phases are core design strategies. The primary goal of phased issuance is to maintain a stable token value while allowing for gradual value appreciation as the game grows and the player base expands.

When implementing, one should first determine the upper limit of the total issuance of tokens, and then gradually release them in stages. In the initial stage, a small amount of tokens will be released, and as the game grows and the number of players increases, the token supply will be gradually increased. This method allows for flexible adjustment of the issuance rhythm according to the development of the game and the participation of players to adapt to changes in the economic system.

For instance, when the number of players drops, the upper limit on the total issuance of tokens helps maintain stability by preventing an oversupply of tokens. With a capped total issuance, fewer tokens are released into the market, which helps mitigate the impact of reduced demand and supports the token value.

Setting a cap on the total amount of token issuance helps to prevent inflation and prevent the value of tokens from decreasing due to excessive issuance. Phased issuance can better manage the supply and maintain the stability of token value.

When the issuance cap is reached, token value is expected to increase due to scarcity. To attract new players at this stage, the game can implement alternative reward mechanisms, such as in-game achievements and non-monetary rewards, or introduce a new generation of tokens with different utilities. These strategies ensure that new players can still find value and incentives to participate in the game.

However, this strategy needs to be alert to potential problems, such as improper control of the release or too fast speed, which may cause oversupply and affect the stability of value. At the same time, the impact of the release strategy on player participation and game ecology must be considered to avoid limiting the development space of players.

When designing a release strategy, a reasonable plan should be developed based on the actual game and player feedback. Transparency and fairness are crucial to ensure that players understand the rules and have the opportunity to participate, thereby ensuring the stability and sustainable development of the game's economic system.

3.1.4. Introducing a New Token Lock-Up Period

The implementation strategy involves the game design team setting lock-up periods and unlocking conditions for new tokens. Players need to follow the rules and unlock additional token rewards by participating in specific activities or achieving game achievements. This incentivizes players to actively participate, increasing their engagement and loyalty. The setting of lock-up periods also helps to improve the stability of tokens.

However, the introduction of token lock-up periods and conditional releases may bring problems, such as unreasonable conditions or improperly designed reward mechanisms, which may cause player dissatisfaction. In order to avoid over-reliance on token releases to attract players, other game design elements should be combined to improve the overall experience.

When designing the token lock-up period and conditional release mechanism, it is necessary to consider player motivation and the long-term goals of the game. It is crucial to ensure that the reward mechanism can stimulate player enthusiasm and participation. At the same time, clear rules should be provided to reduce misunderstandings and dissatisfaction and maintain the stability and healthy development of the game community.

3.2. Player Incentive Mechanism

In the field of Web3 games, the staking mechanism is widely adopted as an incentive to promote the active participation and continuous participation of players. Players can obtain corresponding rights or rewards in the game by staking a certain number of tokens.

The mechanism is designed to encourage players to stake tokens on the platform by offering rewards or game rights. These rewards may include additional game resources, rare props, or higher token returns. Staking not only motivates players to participate more actively in the game, but also increases their commitment and loyalty. In addition, staking helps to stabilize the game economy and increase the value of tokens by reducing the circulation of tokens [42].

Although staking mechanisms have potential, they need to be designed carefully to avoid negatively affecting player behavior. If the rewards are not attractive enough or the staking period is set to be too long, it may lead to player churn or dissatisfaction. Therefore, when designing a staking mechanism, it is important to balance the attractiveness of the rewards with the cost of staking to ensure that players receive a reasonable return while maintaining their long-term participation.

In order to maintain the long-term activity of players, the staking mechanism should be combined with other incentives to provide a diverse gaming experience and rewards. In addition to staking rewards, a reward distribution mechanism can also be designed based on the activity and contribution of players. In addition, regularly launching activities

and tasks to continuously attract players' interest and participation will help promote the positive development of the game community.

3.3. Long-Term Sustainability

3.3.1. Diversification of Revenue Streams

To achieve long-term sustainability, P2E games must diversify their revenue streams beyond mere token transactions. This can include in-game purchases, subscription models, advertising, and partnerships with other gaming platforms and brands. By creating multiple income sources, the game can reduce its reliance on token value fluctuations and provide a more stable financial foundation.

3.3.2. Robust Economic Design and Balancing

A well-designed and balanced game economy is crucial for long-term sustainability. This includes, as mentioned in Section 3.1, establishing a reasonable token recovery mechanism and the use of financial instruments such as interest rates and gambling banks, as well as the strategy of token issuance. Developers must continuously analyze economic data and player behavior to make informed adjustments that maintain economic stability and player satisfaction.

3.3.3. Enhancing Player Trust and Security

Trust is a cornerstone of any successful P2E game economy. Ensuring the security of player assets and transactions through robust cybersecurity measures and transparent operations is vital. Using blockchain, token transactions can be decentralized and transparent, reducing information asymmetry and fraud risks and enhancing players' trust in the platform. Smart contracts provide a safe and reliable execution mechanism to protect players' rights. Additionally, one of the main motivations for adopting blockchain technology in various applications, including Web3 games, is its anonymity feature. If games used methods to ensure network anonymity, they would better protect players' privacy and become more attractive. Francesco Buccafuri proposed a new protocol called MQTT Anonymous (MQTT-A). This protocol uses P2P collaboration through an intermediate bridging proxy. It propagates publish/subscribe messages via random paths, so the final public broker cannot identify the actual sender. This ensures that users' IoT devices communicate anonymously with companies, preventing companies from tracking and analyzing users, thereby protecting their privacy [43].

3.3.4. Adapting to Technological Advancements

The continuous advancement of blockchain technology has brought new opportunities for the long-term sustainability of P2E games. Staying at the forefront of emerging technologies such as virtual reality (VR), augmented reality (AR), and artificial intelligence (AI) can provide new avenues for player engagement and innovation. As technology develops, new applications can also be explored, such as NFT-based asset transactions and cross-chain interoperability, to further enhance user experience and the sustainability of games. Therefore, reasonable policy formulation and innovation in blockchain technology will jointly promote the long-term development of the P2E game industry.

3.3.5. Addressing Regulatory Challenges

When evaluating the long-term sustainability of P2E games, policies and regulations play an indispensable role. Governments and regulators may implement multiple policies aimed at regulating the cryptocurrency and blockchain game markets. These policies may involve the regulation of token issuance and trading platforms as well as user identity verification and anti-money-laundering measures. Reasonable policies can enhance market confidence and promote the healthy development of the industry.

For instance, a regulatory framework that encourages transparency and accountability in token issuance can foster investor trust and attract more participants to the market.

Clear guidelines on trading platform operations can prevent fraud and ensure fair trading practices, thus maintaining a stable and trustworthy environment for gamers and investors alike.

User identity verification and anti-money-laundering measures, if implemented thoughtfully, can mitigate risks associated with illicit activities, further bolstering the legitimacy and attractiveness of the P2E gaming industry. Policies that promote innovation, such as tax incentives for blockchain startups or grants for research and development, can stimulate growth and drive technological advancements within the industry.

However, overly strict or inappropriate policies may have a negative impact on gaming platforms and token issuers, limit their growth potential, and even cause market panic and instability. For example, excessive regulatory burdens could stifle innovation by imposing high compliance costs on new and small enterprises, making it difficult for them to compete with established players. Inconsistent or ambiguous regulations could create uncertainty, discouraging investment and hindering the overall development of the P2E ecosystem.

Therefore, when formulating policies, policymakers need to balance the relationship between maintaining market order, protecting investors' interests, and fostering industry innovation and development. By adopting a balanced approach, regulators can ensure the continued prosperity of the P2E gaming industry, supporting its evolution into a mature and sustainable sector.

4. Conclusions

In this study, we delved into the characteristics of the token economy system of Play-to-Earn (P2E) games and their sustainability challenges. We found that the profit potential or investment value of the token is the core factor affecting the change in the number of active users of P2E games. As the token price steadily increases, the number of active users of the game will also increase. However, once the price growth slows down and the token value decreases, user activity may also decrease. We verified this conclusion by analyzing the number of daily active users and token prices of popular P2E games such as *Axie Infinity* and *Alien Worlds*.

We believe that the increase in token prices is mainly affected by external stimuli, including in-game economic incentives, general market sentiment, and technological progress. Finally, we explored how to enhance the stability of the P2E game economy from multiple dimensions, including game design and player incentive mechanisms.

In order to accurately predict the future direction of the P2E gaming industry, we must pay attention to its sustainability and fairness, and ensure that the token economy system achieves the optimal long-term operating balance. Understanding the characteristics and challenges of the token economy system will help us guide the healthy development of this emerging industry. This will create a more prosperous and sustainable future for both players and the gaming industry.

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