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EMERGING TECHNOLOGIES

INTRODUCTION

Blockchain technology and cryptocurrencies have enabled the creation of a new type of online gambling application. One which uses a cryptocurrency network to process payments instead of a bank or operator. Additionally, part or all of the gambling application may be executed by a cryptocurrency network, which raises some important regulatory and consumer protection concerns.

This report provides a general overview of blockchain and cryptocurrency technology, and how they are used for gambling. It then describes how the cryptocurrency gambling landscape is developing, its prevalence, and some broader concerns around consumer protection in this new and quickly evolving domain.

Key point: Gambling applications executed on a cryptocurrency network are known as decentralised gambling applications [3]. Not all cryptocurrency gambling occurs through such applications.

BLOCKCHAIN TECHNOLOGY

A blockchain is a data structure which consists of a sequence of chunks of data (known as blocks) which are appended one after another to form a chain. This appending process involves computing a cryptographic hash (a unique summary of the data in that block) of the previous block, such that all of the blocks together form a one-way chain.

For example, one block in a blockchain may contain a list of guests at a hotel in the month of February, plus a hash of the January block. The next block may contain the guest list for March, plus a hash of the February block. This chaining process means that if someone wanted to maliciously change the guest list for any of the previous months in the blockchain, the rest of the chain would no longer be valid as the hashes of the blocks would have been changed.

This one-way-ness of a blockchain is not so useful if the blockchain is stored on a single computer as any invalid hashes could quickly be recomputed and replaced. However, if a network of computers all store up-to-date copies of the same blockchain and create a way to add new blocks to it, it becomes a secure, one-way collection of data which quickly becomes prohibitively difficult to change in a malicious way - especially as the number of computers in

the network grows. Cryptocurrencies leverage this ability to store transaction data which can be updated by anyone on the network.

CRYPTOCURRENCY

Cryptocurrencies use a network of computers to store and update a blockchain containing transaction data. This blockchain of transaction data is sometimes referred to as a distributed ledger as it's duplicated across multiple computers. Some cryptocurrencies can store executable code alongside transaction data in their blockchain. These pieces of code are known as smart contracts and can be executed by users on the network by transacting with them in the same way as a regular account. I use the term account here as it is most intuitively comparable to a bank account. A smart contract may be as simple as a piggy bank program which returns any received funds after a period of time, or as complex as an entire online casino with multiple games, sub-currencies, and more.

CRYPTOCURRENCY ACCOUNTS

Before gaining a deeper understanding of the use of cryptocurrencies for gambling, a working knowledge of cryptocurrency accounts is needed. Cryptocurrency accounts (usually referred to as wallets) are simply a pair of cryptographic keys which can be considered similar in function to an email address and password. A user can receive funds to one (known as a public key), and can send funds from their account using the other (known as a private key).

This pair of cryptographic keys is all that is needed for anyone to receive, hold, and send cryptocurrency on a given network, and is an important difference between the existing global banking system in which official identification and multi-factor authentication is usually required, and the growing system of cryptocurrencies. It should be noted that at no point in the creation of a cryptocurrency account is a third party needed, nor is any individually identifiable information required.

PREVALENCE

Understanding the prevalence of cryptocurrency gambling means understanding two distinct innovations. The first concerns existing online operators who begin to accept cryptocurrency deposits and withdrawals in their sites. These platforms are functionally the same as they were before, but now simply accept a new currency. The second concerns the new archetype of decentralised gambling applications, in which payments and game logic are processed by a cryptocurrency network (using smart contracts described above) instead of a centralised server.

The first innovation - operators accepting cryptocurrency - while worthy of deeper understanding in its own right, is not as technologically significant as the games being played and the underlying processes have not fundamentally changed.

The second innovation - decentralised gambling applications - pose not only a credible threat to the very existence of centralised operators, but introduce significant technical limitations on the enforcement capabilities of regulators, and of customers to make use of important protection measures. This considered, they also bring several benefits to consumers and researchers which can be traced back to their inherent transparency, as discussed below.

Furthermore, given the global scale of cryptocurrency networks it is difficult to break the prevalence of these applications down by country or even by continent. Further frustrating efforts prevalence measurement efforts is the existence of multiple cryptocurrencies, each with subtly different data structures. The existence of blockchain explorers (websites which provide access to given cryptocurrency blockchains) and application ranking services greatly simplifies quantifying prevalence, however, understanding prevalence remains a task of global scale.

PREVALENCE IN NUMBERS

Decentralised application ranking services such as StateOfTheDApps.com or DAppRadar.com mean anyone can get up to date information about the number of users, total spending, and other key metrics across the entire decentralised gambling ecosystem. These services both show the exponential distribution of applications in terms of the total volume transferred (funds sent to the contract), with the Dice2.win application dominating the market. With almost $50M in cryptocurrency spent over the past 7 days across just 70 users, it is clear that this platform is not currently mainstream, but shows the underlying technological capability to process bets in large amounts.

The top 10 decentralised gambling applications by 7 day weekly volume, which use a number of different cryptocurrencies, appear to attract weekly usage by approximately 4000 users, which even at the aggregate level fails to compete with just one small to medium sized centralised online casino. It is also not clear whether or not these 4000 users are unique, or whether they are a smaller cohort playing across multiple applications.

This limited player base indicates one or more of a number of scenarios, namely;

1. The existence of these applications is simply not well known
2. The technologically advanced nature of these applications deters mainstream adoption

3. Cryptocurrencies are less attractive than fiat currencies as a medium for gambling, perhaps due to their volatility

On top of their relative youth [2], this non-exhaustive list presents just some of the reasons behind the lack of uptake in decentralised gambling applications. As adoption grows and awareness of the value and transparency these applications *can* provide to players, prevalence by volume and by player count is likely to increase.

Furthermore, the technology behind these applications is steadily becoming better understood, inviting variants and remixes of their designs and architectures to provide new and different ways to play using cryptocurrencies. This constant and ever-accelerating innovation, driven largely by the open nature of such applications, means the future directions decentralised gambling could take are many, and could impact the gambling market in unpredictable ways.

A final area to consider regarding the prevalence of these applications going forward is the stance that existing centralised operators will take towards them. One path may involve embracing the transparency of this new way to play by providing decentralised equivalents of their existing games. Others may not be so accepting, or may not even consider this new technology a threat until its player base matures. In any case, as with cryptocurrency in general, predicting future prevalence is a real challenge.

BENEFITS OF DECENTRALISED GAMBLING

The use of cryptocurrency networks to process payments and compute game logic has several significant advantages. These stem from the benefits inherent to the data structure of a blockchain, and the publicly accessible nature of the blockchain itself. They include;

1. Operator source code access (with source code verification)
2. Total transparency of all player and operator transactions
3. Immutable historical record of operator actions

These three benefits apply to operators, players, and regulators, and can be considered the main draw of decentralised applications over centralised alternatives. However, as with many emerging technologies there are some important drawbacks.

DRAWBACKS OF DECENTRALISED GAMBLING

Whilst the benefits of decentralised gambling applications are attractive in comparison to existing online operators, it is their availability to at-risk players which should attract most scrutiny, and which is afforded its own section below.

In terms of the drawbacks of the applications themselves in a broader sense, there are several performance limitations inherent to the cryptocurrencies they are implemented atop. For example, transactions on the Ethereum network - on which the Dice2.win application resides - take approximately 30 seconds to execute. This means that fast-cycle games are technologically not possible using this particular network, although they have been implemented on the EOS network, for example.

An additional drawback of some cryptocurrencies is the use of transaction fees which must be paid in order for the network to process a given transaction. Such fees don't have a centralised equivalent and are usually not large (up to a few pence per transaction), however, this does not apply to all cryptocurrencies.

OPPORTUNITIES FOR SAFER GAMBLING

The use of blockchain technology for cryptocurrencies, and then cryptocurrencies for gambling, provides a number of powerful benefits in terms of safer gambling. These broadly stem from the availability of transaction data for research, and the inherent transparency of operators.

TRANSACTION DATA FOR RESEARCH

Of the several branches of gambling research, player behaviour tracking concerns the use of transaction data to understand how different player behaviours may be reflected in their transaction sequences. The use of cryptocurrencies for gambling (in any form) adds these transactions to the given cryptocurrency blockchain making them accessible for research [1]. Whilst a collection of transaction data in isolation may not be significant for safer gambling research, it does enable the development of tools and software capable of incorporating other data streams such as demographic data from surveys to build a more comprehensive methodology for understanding of cryptocurrency gambling which may then be applied to other forms of gambling. Mixed method studies incorporating both transaction, demographic, and gambling severity data, present a powerful and relatively unexplored opportunity for insights.

OPERATOR TRANSPARENCY

As discussed above the nature of incorporating a public cryptocurrency into a gambling application brings full operator transparency. This benefit can be translated into an opportunity for safer gambling as consumers and regulators have the ability to freely inspect the source code (if available) behind such applications. This transparency not only encourages fairer implementations of games (as opposed to fixed games from rogue operators), but also inherently invites the addition of responsible gambling technologies into the games themselves. No examples of the latter have been found following research for this report, yet their deployment as a marketing opportunity for developers may spur their development.

RISKS FOR SAFER GAMBLING

In order to set out the scale of the risk to consumers that decentralised gambling applications pose both at present and in the future, the technical properties of the underlying technology must be considered.

PSEUDO-ANONYMITY

Most obviously, the lack of customer information needed to create a cryptocurrency account (wallet) on any cryptocurrency network for the purposes of gambling poses a notable threat both in terms of age restriction to games, and in terms of anti-money laundering. Furthermore, the pseudo-anonymity that identification using only a pair of cryptographic keys (per player) provides means that tracking down users whose spending may trigger consumer protection tools becomes almost impossible.

The pseudo-anonymity of users may be remedied through legislated cooperation with cryptocurrency exchanges, which act as a point of conversion between fiat and cryptocurrencies, however no governments to date have explored such an approach.

LACK OF CONSUMER PROTECTION ENFORCEMENT

The decentralised nature of the code behind each of the platforms means that enforcement of consumer protection measures and KYC procedures is practically impossible. A comparable scenario would be a slot machine placed in the middle of a public space such as a park whose internal workings could not be easily manipulated. In this scenario any member of the public is free to interact with the machine without identification, and authorities are unable to intervene other than by attempting to restrict access (shut down websites) or simply by educating the public on the risks involved.

INTERNATIONAL REACH

As with many off-shore operators, decentralised gambling applications can be accessed from any internet connected device unless explicitly blacklisted at the government/ISP level. This international availability means that the benefits and drawbacks described above can be felt, but not necessarily measured, by any country in the world, and represent a global challenge to gambling regulation.

An intuitive comparison would be online piracy sites which instead of hosting copyrighted content themselves simply provide an interface to distributed content servers to their users. The website components of decentralised gambling applications operate in a similar way (by providing an interface between player's browsers and a blockchain), making the difficulty, cost, and scale, of the anti-piracy enforcement a useful historical example of which enforcement and regulation tools may (or may not) be effective.

FUTURE DIRECTIONS

The pace of innovation in the cryptocurrency domain is impressive by any measure, and as existing gambling operators take note there are a number of future directions they may take. As discussed above simply accepting cryptocurrency as payment as an online operator utilises only a fraction of the power that this technology allows. A possible future involves increasing the transparency of operator's centralised games as they compete to offer provably fair games against decentralised applications.

TECHNOLOGICAL ADVANCES MEAN INCREASED ACCESSIBILITY

Technological advancements in usability, and streamlining the onboarding process for new players, also present an important future direction, whereby accessing and using these applications may become as simple if not more so than existing centralised applications. This holds true across usability in cryptocurrencies in general, with a concerted effort to boost usability vital for wider adoption.

ADVERTISING AND ADOPTION

Advertising decentralised gambling applications is a precarious task given some country's strict laws prohibiting advertising unlicensed gambling. However, as laws catch up to this new technology, there may also be a future where the existence of these applications is more widely known, and where the more technically advanced portion of players grows as a result.

In any case, the future of decentralised gambling applications, and cryptocurrencies in general, is immensely variable. It is now up to researchers, policy makers, and players, to reach

a unified understanding of the advantages, disadvantages, and ultimately the regulation and enforcement around gambling using this new technology.

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