

Information Diffusion and Market Efficiency in Football Lottery Betting: A Complex Network Analysis of International Football Events

Siddharth A. Banerjee

School of Computing, Clemson University, Clemson, SC, USA.

banerjee917@clemson.edu

Mikkel A. Zimmerman

Department of Computer Science, University of Houston, Houston, TX, USA.

mikkel1977@uh.edu

Jan Alviroz

Department of Electrical Engineering and Computer Science, University of Kansas, Lawrence, KS, USA.

jan.work@ku.edu

Seahal Gupta

School of Electrical Engineering and Computer Science, Oregon State University, Corvallis, OR, USA.

sahilmail@oregonstate.edu

Abstract

Global football lottery systems constitute a multi-billion-dollar socio-technical infrastructure in which information diffusion profoundly shapes collective wagering behavior and market outcomes. This paper presents an interdisciplinary analysis of football lottery betting through the lens of complex network theory, examining how the structural properties of betting communities govern the transmission of information and influence market efficiency during major international tournaments. We conceptualize bettors and their communication channels as scale-free, small-world networks with pronounced community structure, and we explore the dynamics of information cascades, the role of influential hubs, and the propagation of algorithmic betting strategies. The discussion integrates perspectives from behavioral economics, information systems, and sports analytics to evaluate structural trade-offs between transparency, fairness, robustness, and sustainability. A system-level examination of governance architectures reveals how regulatory frameworks can be designed to mitigate manipulation, reduce problem gambling harms, and preserve the integrity of wagering markets. By situating football lottery betting within the broader discourse on networked socio-economic systems, this study identifies principles for constructing equitable, resilient, and efficient betting infrastructures that can adapt to the accelerating pace of data-driven innovation and global connectivity.

Keywords

football lottery; market efficiency; complex networks; information diffusion; betting markets; network governance; system architecture; fairness; sustainability.

1. Introduction

Football lottery betting during international events such as the FIFA World Cup, the UEFA European Championship, and the Copa América aggregates the expectations of hundreds of millions of participants across governmental, licensed, and peer-to-peer platforms. These platforms are not merely financial marketplaces; they are richly connected socio-technical systems in which information about team form, player injuries, tactical setups, and public sentiment propagates through a web of social ties, media channels, and algorithmic feeds. Observing the resulting betting patterns reveals emergent phenomena—herding, bubbles, and sharp revaluations—that traditional models of rational expectations struggle to explain. Complex network theory provides a powerful vocabulary and analytical toolkit to unpack the structural mechanisms that underlie these phenomena and to re-examine the concept of market efficiency in the distinctive institutional context of lottery-type wagering.

The foundational work on network topology has established that many real-world social and technological networks are not random but instead exhibit scale-free degree distributions or small-world properties. Barabási and Albert [1] demonstrated that networks growing through preferential attachment give rise to a small number of highly connected hubs, a feature that radically alters diffusion dynamics. Watts and Strogatz [2] introduced the small-world model, where high clustering and short average path lengths enable information to traverse large populations rapidly. Both insights are directly relevant to the communities that form around football lotteries, where a few tipsters, journalists, and celebrity enthusiasts can command outsized influence and where a rumor originating in one language community can cascade across the globe within minutes. The theory of informational cascades developed by Bikhchandani, Hirshleifer, and Welch [3] provides a behavioral microfoundation for understanding how early public bets can suppress privately held information, leading the market to converge on outcomes that are fragile with respect to small shocks.

The broader economics of wagering markets has a long tradition of testing efficiency. Sauer [4] surveyed the institutional features of pari-mutuel and fixed-odds markets, documenting persistent anomalies such as the favorite-longshot bias. Thaler and Ziemba [5] analyzed anomalous patterns in parimutuel betting at racetracks and lotteries, revealing how psychological biases and market structure co-produce departures from efficiency. Gray and Gray [6] tested market efficiency in National Football League betting and identified exploitable patterns that cast doubt on the semi-strong form of efficiency. Within association football forecasting, Hvattum and Arntzen [7] evaluated ELO-based rating systems and underscored the fact that even simple, publicly available metrics can capture information that shapes betting lines. Yet these contributions have predominantly treated the market as a monolithic information processor, overlooking the networked microstructures through which individual assessments are formed, shared, and aggregated. The present paper addresses this gap by offering a system-level complex network analysis that links the topology of betting communities to the diffusion of information and, ultimately, to the temporal dynamics of market efficiency.

2. The Football Lottery Betting Ecosystem: Architecture and Information Flows

Contemporary football lottery systems are organized around three dominant architectural archetypes: government-run pari-mutuel pools, licensed fixed-odds sportsbooks, and peer-to-peer betting exchanges. In a pari-mutuel lottery, all wagers are pooled, and the payout odds are determined only after the betting period closes, directly reflecting the collective distribution of bets. This transparency regarding the crowd's allocation creates a reflexive information channel: participants can observe provisional odds during the wagering window

and adjust their positions accordingly, turning the market into a continuous computation of popular sentiment. Fixed-odds bookmakers, by contrast, set prices based on risk models and market-making algorithms, and they update these prices in response to incoming money and external signals. Betting exchanges reintroduce a direct market microstructure, allowing participants to offer and accept bets, thereby generating an order book that aggregates heterogeneous beliefs in a manner analogous to financial exchanges.

Each architecture generates a distinct pattern of information flows. In pari-mutuel systems, the real-time feed of pool totals essentially broadcasts the sentiment of the entire bettor population, compressing distributed knowledge into a single signal. Fixed-odds platforms, however, must infer information from a combination of data streams: media reports, social media chatter, syndicate activity, and proprietary scouting networks. The operator's risk management function acts as an informational intermediary, translating raw signals into continuous price adjustments. Betting exchanges introduce a further layer of complexity because the visibility of unmatched bets and the ability to see the depth of the order book empower traders with better network connections—those who can collect and process information faster—to profit at the expense of less connected participants. During international football tournaments, these architectural differences are amplified by the compression of match schedules, the influx of casual bettors unfamiliar with market conventions, and the multilingual, multi-platform nature of the information environment. The topology of the communication network among bettors—whether it is formed on Twitter, WeChat, Reddit, WhatsApp groups, or dedicated betting forums—determines which signals become globally visible and which remain confined to local clusters.

3. Complex Network Theory and the Structure of Betting Communities

Modeling the soccer betting community as a complex network requires mapping both the social relationships and the information-sharing pathways that connect bettors. The comprehensive review by Boccaletti and colleagues [8] established a unified framework for analyzing network structure and dynamics, covering topological characterization, community detection, and the interplay between structure and function. Newman [9] synthesized the understanding of complex networks in social, technological, and biological contexts, emphasizing that real networks typically exhibit heterogeneous degree distributions, community organization, and hierarchical modularity. Applying these principles, researchers can conceptualize nodes as individual bettors or aggregate betting accounts, with edges representing information exchange, co-betting similarity, or follower relationships. The resulting network is highly likely to be scale-free, with a small number of influential nodes—popular columnists, social media influencers, or successful syndicate leaders—maintaining a disproportionate number of connections and serving as hubs through which betting-relevant signals are amplified.

The community structure of these networks is equally critical. Guimerà and Amaral [10] introduced functional cartography methods that classify nodes according to their roles within and between modules, enabling the identification of node types such as provincial hubs and connector hubs. In the betting context, provincial hubs dominate within a single language group or fan community, reinforcing local consensus, while connector hubs bridge distinct clusters and facilitate the cross-pollination of strategies and narratives across national or cultural boundaries. Clauset, Newman, and Moore [11] developed a fast algorithm for uncovering community structure in very large networks, making it feasible to apply these concepts to real-world datasets derived from social media and platform transaction logs. The

partitions revealed by such algorithms often correspond to natural groupings: supporters of particular national teams, geographical regions with shared lottery providers, or subcultures defined by a preference for certain analytical styles. These communities act as semi-autonomous echo chambers in which information cascades can amplify localized beliefs, such as persistent overestimation of a sentimental favorite, even when global evidence suggests a contrary outcome. The presence of bridge nodes connecting these modules determines the extent to which a locally dominant narrative can become a market-wide phenomenon.

4. Information Diffusion Dynamics in Betting Networks

Once the static network topology is characterized, the focus shifts to the dynamic processes by which information diffuses across its edges. Information cascades, as originally formalized in [3], provide the baseline mechanism: when individuals observe the actions of a growing number of predecessors, they may rationally ignore their own private signals and follow the crowd, a process that generates fragile social equilibria. In football lottery markets, cascading behavior manifests in phenomena such as sudden, large-volume shifts toward a previously unfancied team after a prominent television analyst delivers a confident prediction. The speed and reach of such cascades are mediated by the network properties identified earlier. In scale-free networks with prominent hubs, a single tip can trigger a global cascade within minutes because the hub's endorsement simultaneously reaches a large fraction of the population. Conversely, in more clustered networks with fewer long-range ties, cascades may remain contained within a community, creating localized mispricing that persists until bridging nodes carry the information further.

A particularly consequential form of information flow is the diffusion of algorithmic and data-driven strategies for predicting match outcomes. The digitization of historical match data and the democratization of machine learning tools have empowered a new wave of bettors who approach the lottery as a computational problem. A novel playing method for the guessing football lottery [12] exemplifies how formalized technical approaches are introduced into the betting ecosystem. Such methods, when shared through online forums, subscription services, or open-source code repositories, propagate similarly to technological innovations in other sociotechnical systems. Complementary developments include dynamic rating systems based on relative score discrepancies that provide continuous assessments of team strength [13], empirical investigations of the time-varying efficiency of online football betting markets [14], and the application of ensemble machine learning models to predict English Premier League results with considerable accuracy [15]. The diffusion of these techniques has a dual effect: initially, early adopters may exploit market inefficiencies, generating abnormal returns, but as the strategy disseminates through the network and becomes embedded in the collective forecasting apparatus, market prices adjust to reflect the newly incorporated information, eroding profitability. This dynamic is a concrete manifestation of the semi-strong form of market efficiency, mediated not by a mythical homogeneous information set but by the heterogeneous connectivity of bettors.

The temporal dimension of diffusion is paramount during international tournaments. The tournament structure imposes a cadence of match days with brief intermissions, during which information about the previous day's results, injuries, and tactical revelations must be digested and incorporated into the next round of bets. Network congestion and unequal access to real-time data can cause systematic delays in price formation. Bettors who are deeply embedded in high-bandwidth information networks may react to goal alerts or lineup announcements minutes before less connected participants, creating temporary arbitrage that

would not exist in a frictionless, fully connected system. Moreover, the large influx of novice bettors during the knockout stages, many of whom are only loosely connected to the core network of experienced tipsters, introduces noise that can temporarily destabilize the consensus and generate windows of inefficiency. Thus, the interaction between network topology and diffusion kinetics offers a richer, more realistic account of market dynamics than models that assume all participants share a common information set instantaneously.

5. Market Efficiency in Lottery-Type Betting Markets

The meaning of market efficiency in the context of football lottery betting requires careful reinterpretation. In the financial economics tradition, as formalized by Fama [18], an efficient market is one in which prices fully reflect all available information, implying that no trading strategy can achieve risk-adjusted returns above the market benchmark. Translating this concept to wagering involves comparing the subjective probabilities implied by odds with objective outcome probabilities, net of the bookmaker's overround or the lottery's takeout rate. Forrest and Simmons [16] examined the economic peculiarities of sport-related gambling markets and noted that lottery-type products frequently attract casual participants with limited ability to process statistical information, introducing systematic noise that can push prices away from efficient levels. Paul and Weinbach [17] studied college football point spreads and identified inefficiencies correlated with public sentiment and media coverage, reinforcing the view that betting markets are not perfectly rational.

The behavioral finance literature supplies the microfoundations for these observed inefficiencies. Shiller [19] argued that psychological factors such as overconfidence, representativeness, and attention-driven decision-making cause substantial and persistent deviations from the predictions of the efficient market hypothesis. Kahneman and Tversky's [20] prospect theory demonstrates that individuals overweight low probabilities and exhibit loss aversion, a combination that naturally gives rise to the favorite-longshot bias so ubiquitous in wagering markets. When bettors perceive a chance of winning a large payout on an unlikely outcome, they systematically overbet the longshot relative to its true probability, while underbetting the favorite, thereby compressing the odds. The behavioral tendency interacts with network structure: hubs that specialize in promoting outsider teams can amplify this distortion across their follower communities, generating persistent mispricing that persists until arbitrageurs with superior resources counteract it. The presence of cognitive shortcuts and social influence in the formation of betting decisions implies that the market can remain inefficient over extended horizons, a finding that challenges the strong form of the efficient market hypothesis but is fully consistent with a semi-strong account in which only the diffusion of sophisticated analytical signals gradually corrects misalignments.

From a systems perspective, market efficiency is not a binary property but a continuum that varies across different segments of the betting network. Within tightly knit expert clusters that employ advanced forecasting models and share data-driven assessments, prices may rapidly converge to efficient levels for those matches receiving intensive analytical scrutiny. Meanwhile, in loosely connected communities of casual bettors who rely primarily on media narratives and heuristic reasoning, inefficiencies can endure throughout the entire wagering window. During international tournaments, the influx of millions of first-time participants who are weakly integrated into the information-processing fabric of the betting network creates a structural asymmetry: the market simultaneously contains a core of efficient pricing for high-profile fixtures surrounded by a periphery of systematically biased valuations for less prominent matches. This fragmented efficiency landscape necessitates a network-aware

approach to regulation and platform design, one that recognizes the uneven distribution of analytical capacity and the structural barriers that prevent the seamless flow of corrective information across community boundaries.

6. Governance, Fairness, and Structural Trade-Offs in Betting Infrastructures

The architecture of football lottery systems is not a neutral technical substrate but an embodiment of governance choices that shape who can participate, how information is distributed, and which behaviors are incentivized or penalized. The fundamental tension between market liquidity and informational fairness arises directly from network characteristics. In peer-to-peer betting exchanges, the most connected participants—those with the lowest latency access to event data and the most sophisticated predictive models—can systematically extract value from less informed counterparties, a dynamic that closely mirrors the concerns about high-frequency trading in financial markets. This structure raises profound questions about procedural fairness and the social legitimacy of a wagering infrastructure that converts information asymmetry into predictable wealth transfers.

A governance framework grounded in complex network analysis can address these trade-offs. One dimension involves the deliberate management of hub influence. Regulators and platform operators could impose transparency requirements on highly followed tipsters, mandating disclosure of analytical methodologies and historical track records in a standardized format. Such a requirement would reduce the capacity for hubs to disseminate misleading signals that exploit cognitive biases, without suppressing legitimate expert analysis. Another dimension concerns the re-layering of betting network topologies to enhance resilience against manipulation. For instance, the introduction of randomized delays or batch processing of large wagers during the late phases of betting windows can diminish the advantage of ultra-fast information cascades driven by well-placed nodes, thereby leveling the playing field for all participants. These interventions must be calibrated carefully, however, because reducing hub influence or slowing information propagation too aggressively may degrade liquidity and impair the price discovery function that benefits the entire ecosystem.

Fairness extends beyond individual transactions to encompass systemic distributional effects. The proliferation of algorithmic betting tools across social networks, as exemplified by the dissemination of computationally intensive playing methods [12], risks creating a bifurcated market in which a technologically proficient minority systematically profits at the expense of the majority who lack the skills or resources to deploy such methods. This schism is structurally analogous to the digital divide in broader socio-economic contexts and invites policy interventions ranging from algorithmic literacy programs to the outright prohibition of certain types of automated wagering software. Moreover, the global nature of international football lotteries means that governance decisions made in one jurisdiction—such as restrictions on the use of real-time player tracking data—create regulatory arbitrage opportunities that are exploited by sophisticated syndicates operating across borders. A coordinated international governance architecture, informed by shared network monitoring standards, is essential to prevent a race to the regulatory bottom that would undermine the collective integrity of football wagering worldwide.

7. System Deployment, Robustness, and Sustainability

The deployment of modern football lottery platforms takes place within a layered infrastructure comprising prediction algorithms, real-time data feeds, social media integrations, and payment systems, all of which must operate reliably under extreme demand

spikes during major tournament match days. The robustness of this socio-technical infrastructure is partly a function of its network topology. Systems that are overly centralized around a few data providers, odds compilers, or payment processors are critically vulnerable to single points of failure. A distributed architecture that leverages peer-to-peer protocols and redundant data pathways can absorb shocks—such as distributed denial-of-service attacks, coordinated misinformation campaigns, or liquidity crises during abnormal market movements—without catastrophic degradation of service.

Network science offers principles for designing failure-resistant betting ecosystems. Drawing on the work of Albert, Jeong, and Barabási [22], which demonstrated that scale-free networks are robust to random failures but fragile to targeted attacks on hubs, platform architects must identify and protect the critical nodes whose dysfunction would cascade throughout the system. These critical nodes include the services that compute and disseminate live odds, the authentication servers that verify bettor identities, and the community leaders whose endorsements stabilize or destabilize collective expectations. Redundancy strategies, such as maintaining multiple independent odds feed channels and deploying geographically distributed data centers, can mitigate the risk of targeted disruptions. Additionally, the system must be designed to degrade gracefully: when a hub node fails, the betting community should still be able to rely on local, smaller-scale information sharing to prevent a complete loss of market function.

Sustainability encompasses not only technical resilience but also the long-term social viability of the betting ecosystem. The exploitative extraction of value from vulnerable populations, facilitated by network structures that target problem gamblers with personalized promotional content, is a profound ethical failure that threatens the public acceptance of legal lotteries. A sustainable infrastructure must integrate principles of responsible gambling directly into the network layer. This can involve real-time analysis of betting patterns to detect markers of harmful behavior and the automatic enforcement of cooling-off periods that are synchronized across all platforms linked to a single verified identity. Blaszczynski, Ladouceur, and Shaffer [21] provided a science-based framework for responsible gambling that emphasizes harm minimization and consumer protection, and the translation of this framework into network-level technical specifications remains an urgent challenge. By embedding such protective mechanisms into the topology of the betting system—for instance, by restricting the ability of high-risk users to receive direct promotional signals from hubs—designers can create an infrastructure that balances commercial viability with public health obligations.

8. Policy Implications and System-Level Recommendations

The preceding analysis yields a set of policy implications that span regulatory design, platform governance, and international coordination. First, market integrity monitoring must evolve from traditional transaction auditing to encompass the real-time surveillance of information flows across social and digital networks. This entails deploying network analytic tools that can detect the emergence of coordinated betting patterns indicative of insider information, match-fixing syndicates, or manipulative rumor propagation. Regulators should collaborate with platform providers to establish application programming interfaces that expose anonymized network metrics—such as community structure, cascade depth, and hub centrality—without compromising individual privacy, thereby enabling a new generation of supervisory technology grounded in complexity science.

Second, the design of taxation and revenue distribution mechanisms for government-run football lotteries should reflect the network-mediated nature of value creation. Since platform

operators capture economic rents by intermediating between information-rich hubs and information-poor peripheries, a portion of these rents can be earmarked to fund public goods, including digital literacy initiatives that empower all bettors to evaluate analytical claims critically and to recognize manipulative diffusion tactics. This approach aligns the financial incentives of lottery operators with broader social welfare objectives, transforming the betting infrastructure from a purely extractive enterprise into a vehicle for capacity building and consumer education.

Third, the governance of data rights and algorithmic transparency in football betting must address the new asymmetries created by deep learning models and real-time player tracking data. As the predictive accuracy of ensemble machine learning methods [15] continues to advance, the network nodes that possess proprietary data streams gain an information monopoly that can distort market prices and deter participation from ordinary bettors. Policy interventions could mandate that key data inputs used by professional syndicates be made publicly available after a short embargo period, thereby ensuring that the informational playing field is partially leveled without eliminating the incentives for innovation. The calibration of such embargo periods would need to be sensitive to the tournament calendar, with longer lags permissible during quiet periods and shorter lags during the compressed schedule of major championships.

Finally, the long-term stability of international football lottery markets depends on the establishment of a transnational governance body that can coordinate responses to cross-border network threats, harmonize responsible gambling standards, and enforce transparency norms. The lessons from the regulation of algorithmic trading in financial markets, as analyzed by Kirilenko and Lo [23], underscore the systemic risks posed by unmonitored automated strategies in heavily networked environments. Extending the analogy, an international clearinghouse for betting market data could serve as a neutral repository for the transaction records and network graphs that are necessary for systemic oversight. Such an institution would operate on principles of data minimization and differential privacy, ensuring that individual rights are protected even as the collective dynamics of betting networks become more transparent and governable. McMillen [25] highlighted the complexities of regulating internet gambling across jurisdictions, and the networked character of contemporary football lotteries amplifies those complexities by an order of magnitude, making international cooperation not merely desirable but indispensable.

9. Conclusion

This paper has proposed a comprehensive framework for understanding football lottery betting as a complex networked socio-technical system in which information diffusion dynamics are inseparable from market efficiency outcomes. By modeling the bettor population as a scale-free, small-world network with pronounced community structure, we have illuminated how the topology of communication channels shapes the speed, fidelity, and resilience of information cascades. The interaction between hub nodes that amplify analytical content and the broader community of casual bettors generates a fragmented efficiency landscape, with expert clusters approaching informational efficiency while peripheral communities remain susceptible to persistent behavioral biases. The architectural choices embedded in pari-mutuel, fixed-odds, and exchange platforms create distinct incentive structures that privilege different forms of network connectivity, raising fundamental questions about fairness, transparency, and the distribution of economic benefits.

The governance of these infrastructures demands a shift from static rule-based regulation toward dynamic, network-aware oversight that can detect emergent instabilities, mitigate the exploitative potential of information asymmetries, and embed harm-minimization mechanisms directly into the fabric of betting platforms. The sustainability of the international football lottery ecosystem hinges on striking a delicate balance between the technological innovation that drives predictive accuracy and the protective measures that safeguard consumer welfare and market integrity. As the digital footprints of bettors continue to expand and the techniques of network analysis become more sophisticated, an unprecedented opportunity arises to design lottery systems that are not only profitable and exciting but also equitable, resilient, and aligned with the broader public good. Future interdisciplinary research should empirically map real-world betting networks using platform transaction data, develop agent-based models that simulate cascade dynamics under varying topological and policy interventions, and evaluate the causal impact of transparency mandates on both market efficiency and problem gambling prevalence, thereby closing the gap between the theoretical vision articulated here and the operational realities of global football wagering.

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