DOCTOR OF PHILOSOPHY IN MANAGEMENT

ESSAYS ON EVALUATION OF SKILL DOMINANCE, GAME DESIGN AND ONLINE COMMUNITY OF DAILY FANTASY SPORTS

By

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To Nana, Nani, Maa, and Papa

All that I am, or hope to be, I owe it to you all…

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CONTENTS

Abstract **xii**

1. Introduction **1**

1.1 Background....1
1.2 Rules and Setup of Daily Fantasy Sports (DFS)....3
1.3 Research Gaps....6
1.4 Problem Statements and Significance....8
1.5 Thesis Contribution....11

2. Literature Review **13**

2.1 History and Growth....13
2.2 Legal Status of Online Fantasy Sports (OFS): A Global Overview....15
2.3 Literature on DFS....18
2.4 Stochastic Frontier Analysis: An Overview....27
2.5 Literature on Role of Social Media Information....32

3. Quantifying Skill Dominance in Daily Fantasy Sports **35**

3.1 Introduction....35
3.2 Theory....39
3.3 Data and The Empirical Model....44
3.4 Estimation Strategy....49
3.5 Results....53
3.6 Appendix....61

4. Designing Skill-Dominant DFS Platforms: Moving Towards Data-Driven Regulatory Framework **63**

4.1 Introduction....63
4.2 Why not put a complete ban?....65
4.3 Problem Solving: Where Do We Start?....67
4.4 Designing Skill-Dominant DFS Platforms....70
4.5 Implementing Harm Reduction Strategies: Lessons from Other Countries....76

CONTENTS

5. Understanding Users' Perception: What can DFS Operators Learn from Social Media Platforms? 80

5.1 Introduction 80
5.2 Theory 84
5.3 Data and Estimation Strategy 88
5.4 Results 96
5.5 Appendix 101

6. Conclusion 106

References 110

LIST OF TABLES

TABLE 1.1: Constraints on Team Composition..... 5

TABLE 2.1: DFS and the Global Landscape 16

TABLE 2.2: DFS Laws in the U.S.....16

TABLE 2.3: Studies Examining Effect of Skill..... 20

TABLE 3.1: Variable Description..... 44

TABLE 3.2: Summary Statistics..... 45

TABLE 3.3: Results from Equations 3.7,3.10-3.11..... 54

TABLE 3.4: Robustness to the Choice of Inefficiency Distribution..... 59

TABLE 3.5: Pearson and Spearman Rank Correlations for Inefficiency Estimates 59

TABLE 4.1: Classification of Online Games..... 69

TABLE 4.2: Constraints on Team Composition (Cricket).....75

TABLE 5.1: Topics Identified Using LDA 94

TABLE 5.2: Results from Model 5.1 and 5.2..... 97

LIST OF FIGURES

FIGURE 1.1: Working of DFS Contests 3

FIGURE 3.1: Elements Affecting Contestants' Performance in DFS 42

FIGURE 3.2: Kernel Density Estimate of Contestants' Mean Inefficiency 57

Figure 3.3: Decision Support Framework to Distinguish Games of Skill and Games of Chance 60

FIGURE 4.1: Classification of Online Games 68

FIGURE 4.2: Effect of available options of athletes on contestant's efficiency 72

FIGURE 4.3: Effect of number of athletes in fantasy team on probability that an unskilled contestant wins (Individual Sports) 74

FIGURE 4.4: Effect of Team Composition Constraints on Probability that an unskilled contestant wins 76

FIGURE 5.1: Block Diagram of Methodological Analysis 84

FIGURE 5.2: Model Structure 88

FIGURE 5.3: Word Cloud of User-Generated Content 89

FIGURE 5.4: Quantifying Users' Perception of DFS operators at Aggregate and Category Level 100

ACRONYMS AND NOTATIONS

DFS:	Daily Fantasy Sports
OFS:	Online Fantasy Sports
TFE:	True Fixed Effects
UIGEA:	Unlawful Internet Gambling Enforcement Act of 2006
TF-IDF:	Term Frequency - Inverse Document Matrix
$\mathbf{S_{ict}}$	Score of contestant *i* in her t^{th} contest (labelled as contest '*c*')
$\mathbf{w_c}$	Score of the winner of contest *c*
$\mathbf{ScoreGap_{ict}}$ **or** $\mathbf{y_{ict}}$	$w_c - S_{ict}$. Difference in a contestant's score and winner's score
$\mathbf{Prop10_{ict}}$	Proportion of times contestant *i* was in the top 10^{th} percentile before her t^{th} contest (labelled as contest *'c'*)
$\mathbf{Prop25_{ict}}$	Proportion of times contestant *i* was in the top 10^{th} percentile before her t^{th} contest (labelled as contest *'c'*)
$\mathbf{Prop40_{ict}}$	Proportion of times contestant *i* was in the top 40^{th} percentile before her t^{th} contest (labelled as contest *'c'*)
$\mathbf{ContestSize_c}$	Number of contestants allowed to participate in contest *c*
$\mathbf{ContestType_c}$	1, if the contest *c* was a private contest 0, if the contest *c* was a public contest
$\mathbf{ExpPaid_{ict}}$	Number of paid contests played by the contestant *i* before her t^{th} contest (labelled as contest *'c'*)
$\mathbf{ExpFree_{ict}}$	Number of free contests played by the contestant *i* before her t^{th} contest (labelled as contest *'c'*)

ACRONYMS AND NOTATIONS

$\boldsymbol{\delta_c}$	Unpredictable determinants of score of c^{th} contest's winner
$\boldsymbol{\eta_{ict}}$	Unpredictable determinants of contestant i's score in her t^{th} contest (labelled as contest 'c')
$\boldsymbol{v_{ict}}$	$\eta_{ict} + \delta_c$. Denotes time-varying chance elements influencing contestant i's winnability in her t^{th} contest (labelled contest 'c')
$\boldsymbol{\sigma_v^2}$	$\sigma_\eta^2 + \sigma_\delta^2$. Denotes variance in time-varying chance elements
$\boldsymbol{\tilde{\alpha}_i}$	Contestant (i)-specific effects
$\boldsymbol{u_{ict}}$	Time-varying inefficiency of contestant i in her t^{th} contest (labelled as contest 'c')
$\boldsymbol{\sigma_u^2}$	Variance in time-varying inefficiency
$\boldsymbol{\varepsilon_{ict}}$	$\tilde{v}_{ict} - u_{ict}$
$\boldsymbol{\mu}$	Mean value of time-varying inefficiency
$\boldsymbol{\lambda}$	$\frac{\sigma_u^2}{\sigma_{\tilde{v}}^2}$. Indicator of relative importance of inefficiency and chance
LDA:	Latent Dirichlet Allocation
DTM:	Document Token Matrix
$\textbf{CountTweets}_{it}$	Number of tweets by i^{th} DFS operator in t^{th} month
$\textbf{AvgLikes}_{it}$	Average number of likes received on tweets posted by operator i in month t
$\textbf{UserSentiment}_{it}$	Average polarity value of user tweets in month t referring to operator i
$\textbf{CommunitySize}_{it}$	Number of twitter followers of operator i in month

Abstract

Daily Fantasy Sports (DFS), an emerging business, has observed tremendous growth across many countries. This business has gained attention from policymakers and the judiciary because of several legal cases relating to the format adopted by DFS platforms. As suggested by the judiciary and government think tanks such as NITI Aayog, there is a need to adopt statistical, data-driven approaches to address these problems. This thesis looks at three business problems related to this sector. The first problem concerns skill versus chance dominance in DFS platforms, i.e., whether contestants' performance in DFS contests is influenced more by their skill or by chance elements. Many countries use this criterion to draw a distinction between skill-dominant gaming activities (which are legal) and gambling activities (which are considered illegal in many countries). Chapter 3 of the thesis presents a robust, empirical approach to evaluating the effect of contestants' skill and chance elements on their performance. Using a fixed effect stochastic frontier technique, we model contestants' skills and the random chances they face as two distinct error components determining their success in DFS contests. We distinguish the effect of a contestant's skill not only from chance elements but also from contestant-specific time-invariant factors such as their prior knowledge of the game. Utilizing panel data from cricket-based daily fantasy contests, we find that the effect of skill is significantly greater than that of chance, implying that contestants' skills play a dominant role over chance in determining their success in DFS contests. We also observe that contestants' performances in a contest depend on their past performances, choices of contests, and prior experiences.

While Chapter 3 looks at assessing the effect of skill and chance in DFS setup, Chapter 4 of the thesis examines how we design a skill-dominant fantasy sports. Chapter 4 identifies parameters that affect the skill-chance balance of the game. It is often a problem for the DFS operators to ensure that the design of their gaming platform is skill-dominant by construct. We analytically show that a.) the number of athletes needed in a fantasy team, b.) the number of constraints imposed on team selection (in the case of individual sports and team sports), and c.) the number of available athletes for team creation influence the overall skill-chance balance of the game. This chapter also describes in detail the regulatory challenges faced by state governments and regulators. Based on insights from other countries that faced similar issues, a data-driven regulatory framework has been proposed that a.) classifies online games based on their nature of activities, b.) Lays separate guidelines addressing problems with each of these categories, c.) Draws a distinction between games of skill and games of chance quantitatively, d.) Lays guidelines for designing a skill-dominant game, and e.) Promotes responsible gaming and criminalizes deceptive advertising and fraudulent activities.

In Chapter 5, we discuss how an emerging business like DFS can utilize social media information to interact with its users, comprehend users' experiences, gain insights from user-generated content, achieve more visibility, and expand its online community. Since businesses often use social media platforms like Twitter, Facebook, etc., to engage with their users, announce developments, promote their products, etc., these platforms are considered a medium for the diffusion of social information. Building a larger online community helps firms to disseminate information to a larger audience, gain more visibility and increase their business value. However, research on how firms can grow and learn from their online community is limited. Using a text analytics approach, we quantify the effect of operator-initiated engagement (number of tweets posted by the

operator's official handle and users' response to these tweets) and users' perception of a DFS operator (reflected in user-generated content) and study their association with operator's online community size.

We find that the extent and quality of operator-initiated online engagement and users' perception have a positive, significant effect on the operator's online community size. However, the marginal effect of users' perception of an operator is significantly greater than that of the operator-initiated engagement, thus indicating that users' experiences send a much stronger signal than the official tweets posted by DFS operators in influencing users' decision to join or quit the operator's online community. The chapter also identifies the different user experiences using Latent Dirichlet Allocation (LDA) that have an impact on how users view the business generally and can be used by businesses to find areas that need improvement.

The first two problems addressed in this thesis (Chapters 3 and 4) have direct implications for policymakers working on a regulatory framework for DFS and the online gaming sector in general. The third problem (Chapter 5) aids in understanding user experience and devising strategies to expand the online community. The thesis addresses contemporary issues, uses data-driven approaches to resolve them, and hopes to contribute towards evidence-based policymaking. It contributes to the literature on data-driven decision making, decisions under uncertainty, online community, and online engagement. We expect the thesis' conclusions will aid the DFS industry, the online gaming sector, regulators, and the judiciary in making data-driven decisions.

Keywords: Daily Fantasy Sports; Decision making under uncertainty; Data-driven policy making; Skill dominance, Stochastic frontier analysis; Online gambling; Designing skill-dominant game; Online community