SYMMETRIC EQUILIBRIUM IN CONTESTS:

EVIDENCE FROM A TV SHOW

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2021

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Thesis submitted to the

Institute for Graduate Studies in Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

in

Economics

by

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Boğaziçi University

2021

DECLARATION OF ORIGINALITY

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ABSTRACT

Symmetric Equilibrium in Contests:

Evidence From a TV Show

This paper analyzes symmetric equilibrium resolving the behaviors of the contestants in a cooking contest where points are revealed at the end of each stage. There is an independent observer who evaluates the cook without revealing her grades until the last stage. This research differs from the past papers regarding these two issues. The focus is on the paper by Schüller et al. (2014) where the pro-social behavior in another cooking contest "Come Dine with Me" is analyzed. This paper depicts the differences and compares the results with that research. It constructs equilibrium for this multi-stage game with the assumption that the contestants are rational. It is also observed that the contestants indeed converge to this suggested equilibrium most of the time; although, coordination is not always possible among the contestants. Moreover, this paper explains the deviations from the equilibrium in behavioral concepts. Furthermore, it is examined that the first contestant is disadvantageous, and that the independent observer has an immense impact on the results.

ÖZET

Yarışmalardaki Simetrik Denge:

Bir TV Programından Kanıt

Bu araştırma, puanların her aşama sonunda açıklandığı bir yemek yarışmasındaki yarışmacıların davranışlarını inceleyerek simetrik bir dengeyi analiz etmektedir. Ek olarak, son aşamaya kadar verdiği puanlar açıklanmayan bir bağımsız gözlemci de yemekleri değerlendirmektedir. Bu iki noktada, bu araştırma geçmiş makalelerden ayrılıyor. Buna ek olarak, yarışmacılar üçten düşük bir puan veremiyorlar ya da aynı puanı birden fazla kez kullanamıyorlar. Bu araştırmanın odağını, Schüller ve ark. (2014) tarafından araştırılan benzer bir yarışmadaki ("Come Dine with Me") yarışmacı davranışları oluşturmaktadır. Burada, belirtilen yarışmayla olan farklılıklar gösterilirken sonuçlar da karşılaştırılmaktadır. Bu araştırmada, yarışmacıların rasyonel oldukları varsayımıyla bu çok aşamalı oyun için bir denge oluşturulmaktadır. Çoğu zaman insanların bu dengeye yöneldiği de gözlenmektedir ama yine de yarışmacılar arası koordinasyon her zaman mümkün olmamaktadır. Ayrıca, bu çalışma denge noktasından sapmaları davranışsal kavramlar ile açıklamaktadır. Bunun yanı sıra, ilk yarışmacının dezavantajlı olduğu ve bağımsız gözlemcinin kazanan üzerinde önemli bir etkisi olduğu gözlenmektedir.

ACKNOWLEDGMENTS

First and foremost, I would like to express my sincere gratitude to my thesis advisor Assoc. Prof. Tolga Umut Kuzubaş and co-advisor Prof. Mehmet Yiğit Gürdal for their continuous help and support. Without their knowledge and experience, it would be impossible for me to complete my study.

Besides, I would like to thank my thesis committee members. I would like to extend my sincere thanks to Assist. Prof. Yeliz Kaçamak for their assistance at most stages of this thesis. Additionally, I would like to offer my special thanks to Assist. Prof. Orhan Aygün and Assoc. Prof. Mehmet Oğuz Karahan for their insightful comments and suggestions. I am also thankful to other faculty members at the Department of Economics in Boğaziçi University.

Additionally, I would like to thank the Scientific and Technological Research Council of Turkey (TÜBİTAK) BİDEB for their financial support via the 2210-A Master's Scholarship Program during my studies.

Lastly, I am deeply grateful to my family for their endless support, encouragement and belief in me throughout this process. Without them this research would not have been accomplished.

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CHAPTER 1

INTRODUCTION

Contests are competitions in which contestants display specific behaviors in order to win a prize (Fu & Wu, 2019). Every situation in life can be considered as a contest. It is witnessed in sports, politics, job applications, R&D, and beauty contests. These events form a specific structure in which the individuals compete with each other to be the winner of that situation and to get the prize. The prize is either monetary or non-monetary. Apart from the prize, joining the contest might have some costs. The contests are games that the aim is to succeed. People, or contestants, make an effort to get the prize. By way of explanation, the contestants develop strategies considering the prize, the cost, and other ones' possible strategies in order to win.

Throughout time, it is possible that people have come across different kinds of contests without realizing. There are various contest types, namely, planned or unplanned. As an illustration, political competitions are a kind of unplanned contest since their occurrence is a natural process. In an election, politicians run campaigns, designate and explain their promises. All of these actions are constitutions to their strategies in order to win the election. For this particular reason, political competitions are considered as unplanned contests.

On the other hand, there are planned contests. These are designed in advance, and the contestants join the contest knowing the structure of the contest. One of the examples of these contests is sports game. Sports contestants are thoroughly informed about the setup of the game. They take action to win the game utilizing the best strategy.

Apart from those, cooking contests take place both in real-life and in theory. This is an example of a planned contest that broadcasts on TV. The design of the contest is known by the contestants and the number of contestants is predetermined. There is a certain format of the contest. To mention briefly, in cooking contests each contestant cooks on one day and others grade the cooks through the week. One of the famous shows is the German cooking contest "Das Perfekte Dinner" which is translated as "Come Dine with Me". There is a literature that analyzes this specific contest. The points are not revealed in this German version.

This paper's analysis is based on a Turkish cooking contest called "Zuhal Topal'la Sofrada". The contest's pattern is distinctive from the one cited above in significant aspects. In "Zuhal Topal'la Sofrada" the contestants are the cooks, but they join the show with their mothers-in-law. The brides cook a menu of their choices and the other brides' mothers-in-law grade the cook and the meal of the day. To sum up, the brides and mothers are a team. The brides cook, the mothers grade other brides. The main difference is that the points are revealed at the end of the day; however, contestants cannot see each other while writing their points down. They grade the cook of the day simultaneously and show their evaluations one by one. If anyone is hesitant about the grades before the announcement, there is an option to change the point. However, none of the contestants is able to change their points after it is declared. Additionally, there is an independent observer, who is the host of the show, that grades the contestants. The independent observer's points remain unexplained until the end of the week.

To be more concise about the contest, there are five contestants who cook in a random order during five weekdays. Each day, other contestants grade the cook simultaneously, and then reveal their points. The independent observer also gives a

point; however, she does not reveal them. While grading, mothers choose a point from one to ten to evaluate the cook. Besides, this is not the only rule. It is not allowed to use one or two points if all the meals are completed in time. Moreover, contestants are not able to use the same point more than once. To sum up, contestants should not use less than three or the same number twice. At the end of the week, the independent observer announces the total points, her points, and the total of these two for everyone. Later, the host declares the winner, in the end. The one with the highest overall points is granted an award. The winner gets a monetary reward, yet there is no cost. The others get nothing. If there is a tie, the prize is shared between these contestants.

These two differences in the general design of the contests lead to the comparison with “Come Dine with Me”. The main motivation of this paper is to find equilibrium in this dynamic, single-act game-theoretical design and to compare the results with “Come Dine with Me”. First, a model is created considering the game design, later it is demonstrated that there exists Nash equilibrium of this contest under the assumption that people are rational. Thereafter, it is compared that this equilibrium results with the outcome of the data. The relations with the other contest “Come Dine with Me” are analyzed. Finally, it is determined whether the contestants are doubtlessly rational. If there is bounded rationality, the deviation from the equilibrium is explained in behavioral aspects. The main questions this research figures out are that “What is the equilibrium in this contest?”, and “How does it match up with the evidence?” by both comparing the model with the data obtained from the TV show and comparing the results with the German version of the contest. These questions offer an insight into the rationality of individuals in real-life while facing a contest that gives a monetary reward.

The following chapter is the literature review which examines related articles, and which explains how this paper will contribute to the current literature. Chapter 3 follows with the detailed explanation of the contest itself. Chapter 4 characterizes the model of the game defined. In Chapter 5, the data obtained from the TV show is described and specified the hypotheses. In Chapter 6, the descriptive statistics is demonstrated; the data is analyzed, and lastly, comments on the findings. Both econometric and behavioral analysis results are shown. Finally, Chapter 7 concludes this paper.

CHAPTER 2

LITERATURE REVIEW

The contest theory has emerged along with the competitions. The ordinary real-life situations are analyzed in contest theory. Researchers have conducted papers to analyze unplanned contests as explained in the previous chapter. However, there has been little research about planned contests and much less about TV shows. In addition, those who have studied the latter indicate that Nash is an exception. This paper suggests that convergence to Nash equilibrium is possible assuming people are rational. This chapter mentions briefly about the contest theory and how it has evolved. Later, the structure continues with the cooking contests specifically and ends with this paper's contribution to the literature.

The contest theory goes back a long way. Keynes (1936) relates people's actions in the investment market to the natural result of the newspaper beauty contests. Tullock (1967) first mentions the famous rent-seeking, then Krueger (1974) improves the idea. Szidarovszky & Okuguchi (1997) show that a unique and pure Nash equilibrium exists in rent-seeking. Chowdhury & Sheremeta (2010) generalize the Tullock contest after Tullock (1980) in the Efficient Rent-Seeking chapter.

Another well-known contest type is lobbying. Becker (1983) examines the pressure group competitions in politics. Baye, Kovenock, & Casper G. De Vries (1993) analyze all-pay auctions. Corchón & Serena (2016) provide a recent work by using a survey for both the basic model and the extensions in the contest theory.

Fu & Wu (2019) contribute to different variations to the models of competition. Yildirim (2005) studies contests with more than one round. Ehrenberg

& Bognanno (1990) analyze the incentive effects in tournaments by utilizing empirical work.

When it comes to television shows, many studies focus on the behavior of the contestants, the position effects, gender differences, and so on. Berk et al. (1996) criticize people's rationality in "The Price is Right" which shows that there is bounded rationality.

The contest which the research has been conducted about is related to all papers mentioned above. This paper uses theory to find a Nash equilibrium of the specified cooking contest with multiple rounds while using the empirical work to see whether people act rationally. Even though there are similarities between different types of contests, the most similar contest is "Come Dine with Me". This paper demonstrates a detailed analysis at that contest comparing the differences and the results through the paper.

Ahmed (2011) analyzes the show in terms of gender differences indicating that women and men are not different in competitiveness. However, gender effects are not possible for this paper to analyze since all the contestants are women. Schüller & Upmann (2013) conduct a study of the show from game-theoretical perspectives. They state that the contestants should choose the zero-equilibrium, i.e., the focal point. However, this never happens in the contest. Another equilibrium is played only one time during the show. The researchers try to explain the deviation from the equilibrium mostly by reputation.

The discussion paper by Haigner et al. (2010) investigate the show and reveal that contests, where people evaluate each other, are disadvantageous for the first contestant. Later, Schüller et al. (2014) focus on the pro-social behavior in the show. Their research reports that the following are significant in evaluations: the elegance

of a meal, the position of cooking, having already cooked, and the resemblance between evaluator and contestant. In addition to Schüller et al.'s paper, (2014) this research shows that the finding of Haigner et al. (2010) is undeniably true. The first contestant is disadvantageous as well as the positioning has a significant role on points of the contestants.

Even though there are papers related to different contests, this paper explains the convergence to Nash Equilibrium. The most related research to this paper is the one by Schüller et al. (2014) in which it is indicated that the Nash equilibrium is an exception. In this paper, the opposite is shown. Moreover, some factors such as determining sophistication by looking at the number of ingredients may not be precisely true.

The main reference point of this paper is the research by Schüller et al. (2014). There are two significant differences in the contest designs. First of all, each contestant in the analyzed contest sees others' evaluations at the end of the day. The independent observer grades the contestants without revealing the points until the end of the week. Hence, the independent observer has a significant impact on the total grades assuming that she is unbiased. In Schüller et al. (2014), points are not revealed during the contest. So, the reputation should not be an issue. Nevertheless, contestants seem to care about that and do not use the Nash equilibrium strategies. In this paper, it is observed that even though points are revealed, contestants do not hesitate to use low points. In addition, the independent observer creates another research area.

Moreover, the rule of grading differs in this contest. First of all, one point or two points cannot be used if the dinner is completely ready. Additionally, more crucial difference stems from being able to use each point only once. These

differences bring this paper to another equilibrium point in addition to the theoretical findings and the results. This paper analyzes the behaviors of the contestants.

This paper will contribute to the existing literature considering the differences in the contest design, the Nash convergence in the evaluations of contestants, and the behavioral findings. Besides, it is found out that contestants should not use the same grades for the same opponent in this game design. To sum up, this paper uses a game-theoretical framework, compares it with the data, and later explains the deviations in behavioral concepts.

CHAPTER 3

THE CONTEST

This chapter mentions the general setup, grading system and the rules of the contest in detail. The general setup is similar to the German version “Come Dine with Me”. However, there are significant differences in terms of the rule of the contest.

The general setup of the contest is as follows. The game consists of 5 contestants. Each contestant joins with their daughters-in-law. The latter cook and the former evaluate the meal except for the day they are cooking. To simplify, mothers-in-law and daughters-in-law are considered as one contestant. Additionally, there is an independent observer who hosts the show and also grades the contestants in private.

Contestants cook on separate days through the week and the order is randomly given. Thus, the five-day period constitutes one session, and each day is considered as one round of the contest. In other words, a week in the contest represents a session of five rounds.

The budget to buy ingredients in order to prepare the meal is the same for all contestants. They may or may not spend it all. The menu is specified and declared to the crew beforehand by the contestants and shown to the other contestants before dinner. In season three, the producers of the show have added a mandatory element that each contestant of that specific week has to include in the menu. This mandatory element differs each week. Sometimes it is a specific meal where everybody must produce the exact same thing and other times contestants can use their creativity to cook or bake it. At the end of the week, the independent observer asks contestants’

opinion about the mandatory meal one by one in front of the others before revealing the winner. In addition to the winner of the week, the contestants determine the cook with the best mandatory meal, and this contestant gets a non-monetary reward. The independent observer also shares her choice. In case of a tie, the crew tastes the meal and decides which one is the best.

The main difference from the previously mentioned cooking contest "Come Dine with Me" is that there is an independent observer in this contest. In other words, the contestants are not the only ones to affect the outcome of the contest. The observer tastes the meal, comments on it, and then evaluates it. The grade is added to the points directly. Nevertheless, the contestants do not know their grade until the end of the final day until the independent observer reveals the points. More details are given in the explanation of the grading and the rules.

In the beginning, the dinner was held at the contestants' house. However, with the pandemic, it takes place in the same house provided by the producers of the program. The show is on TV two or three weeks after it is shot. This means the contestants cannot learn the grades of the independent observer in any way.

As it is mentioned before, the contestants cook through the week, and they are graded by the other contestants. In addition to the quality of the meals, the evaluations are affected by the service, table setting, and greetings. Another difference from Schüller et al. (2014) is that points are revealed after everybody writes their own evaluation. At the end of each day, contestants grade the cook simultaneously and show their points one by one. There is an option of changing the grades only if none of the points is revealed. Once declared, nobody is able to change their grades. Before revealing the grades, the independent observer warns the contestants on this issue. They are able to change the grades only before the

revelation of the points. The independent observer sees the grades along with the others. She grades the cook of the day independently and in private after contestants. This constitutes the revelation system of the contest in general which is followed by the rules of grading.

The grading rule in the contest has changed and this paper's focus is on the new rule. To clarify, both the original rule and the new rule is explained in detail. However, this paper does not compare the rules and the adaptation to the new rule due to the fact that the prize has changed through the show. In season one, the reward was ৳10000 whereas, in season two and season three, the reward is increased to ৳15000. In the data, seasons two and three are included. The producers have changed the rule after a few weeks in season two. This results in less data for the old rule with the same prize and that makes the comparison difficult. Hence, the analysis includes only the new rule.

The grading scale is from one to ten. However, it is forbidden to use {1, 2} as a grade, unless there is an unfinished meal. This is valid both for the old and the new rule. As it is suggested, if the meal is complete, contestants choose among {3, ..., 10} to grade each other for 5 rounds (days) in a session (week), cyclically. In case there is an unfinished meal, the contestants are able to use one or two, yet they are not obliged to that. In other words, each contestant grades the other four in different rounds from three to ten for a complete menu and from one to ten for an incomplete menu. The independent observer also evaluates each cook in each round, without showing her grade. The cooks' total points are calculated by summing all the points given to them including the independent observer's grade. At the end of the week, the one with the highest total wins the game, and the others get nothing. In case of a tie, the reward is shared. With the explained rule, all contestants inevitably grade as

low as possible. In other words, they give 3 points to each other. This is an expected and realized argument. In the Schüller et al. (2014) paper, they indicate that people consider their reputation even under a confidential grading system. On the contrary, this contest shows that people tend to play the Nash equilibrium even though the points are revealed.

The analyzed case in this paper is the contest with the modified rule. The new rule is that contestants cannot use same grades in different rounds. If the meal is complete, the contestants should choose among {3, 4, 5, 6, 7, 8, 9,10}. Once a point is assigned to the cook of the day, the contestants are not able to give the exact same point to another cook. To illustrate, a contestant could give point {5} only once. For the following days that specific contestant uses their other points not used on the previous days. The independent observer is still able to grade different contestants in the same way. As mentioned earlier, the one with the highest total wins the game and gets the monetary reward while the other contestants get nothing. The reward is shared in case of a tie. Intuitively, Adhoc characterization of the game is that contestants should play {3,4,5,6} with a probability of 1/4 for each round. The results depend on their cooperation.

To conclude, there are two main differences with “Come Dine with Me” in terms of the contest design and two for the grading design. First of all, contestants’ points are revealed in this contest. It creates a greater reputation issue; however, this is not observed in this contest. The other contest-related difference is that an independent observer evaluates the cooks.

In terms of grading, for a complete meal, contestants are not able to use one or two. They choose from three to ten. Besides, they are not able to use the same point

for different cooks. These two differences bring a different equilibrium from “Come Dine with Me”.

In order to analyze the equilibrium in a game-theoretical perspective, a model is created considering the game design. It is assumed that the contestants in the game are rational and that they try to maximize their utility. First, the strategies and payoffs of the contestants are explained. Contestants look at the point history and select among the set from three to ten and do not use the same point twice. This forms their strategies. The one with the highest total grade gets the monetary award. Without loss of generality, assume their payoff will be 1. On the other hand, the losers get 0 payoffs.

CHAPTER 4

THE MODEL

The contest is be described as a multi-stage game (MSG) with observed actions. Fudenberg & Tirole (1991) define that in MSGs contestants act simultaneously in each stage and observe the past actions. After each stage, the outcome is declared, and this is common knowledge. Thus, this framework is used here to find equilibrium of the specified contest. Assuming that the contestants are rational, they should act rationally in each stage which gives the idea of subgame perfect equilibrium. In an MSG, subgames begin after a given history and continue until the end of the game.

Let t ∈ {1, 2, 3, 4, 5} be the stages of this game and I = {1, 2, 3, 4, 5} be the set of contestants since five contestants compete on five separate days. Each contestant i ∈ I chooses a rating r_i^t in stage t, where $r_i^t \in \{1, 2, \ldots, 10\}$. The history of previously chosen ratings by all contestants up to and including stage t is h^t. That is;

$$h^t = ((r_1^1, r_2^1, r_3^1, r_4^1, r_5^1), (r_1^2, r_2^2, r_3^2, r_4^2, r_5^2), \ldots, (r_1^t, r_2^t, r_3^t, r_4^t, r_5^t)) \quad (1)$$

and the history set $h^0 = Ø$.

A pure strategy for contestant i is $s_i = (r_i^1, r_i^2(h^1), r_i^3(h^2), r_i^4(h^3), r_i^5(h^4))$. The final payoff for contestant i is represented by function $u_i: H^5 \rightarrow \mathbb{R}$ where H^5 denotes the set of all possible stage-5 histories.

Given h^5, $u_i(h^5) =$

$$\begin{cases} f\left(\sum_{j=I} r_j^{t=i}\right) if\ r_i^{t=i} = 0\ and\ r_i^{\hat{t}} \neq r_i^{\tilde{t}}\ for\ any\ \hat{t}, \tilde{t} \neq i\ and\ r_i^t \geq 3\ for\ \forall t \neq i \\ -\infty\ otherwise \end{cases} \quad (2)$$

Due to the fact that contestants are not able to assign a rating to themselves or assign the same rating to other contestants and are not able to assign less than three, one way of modeling the game would be using history-dependent action sets. Instead of this, in order to apply standard equilibrium analysis, a large negative payoff is assigned in case the contestant's strategy does not justify this argument. On the other hand, contestants' utilities are a function of their total grades. Because of the independent observer' effect on the results, including the contestants' total grades alone is not enough. Nevertheless, this function is directly proportionate to the total grades. Considering that the grades get higher, the probability to win the contest increases. In the end, only the winner gets a positive payoff while the others get zero.

The contest payoff function actually represents a probability and is written under the formula of;

$$\frac{e^{\sum_{j=I} r_j^{t=i}}}{e^{\sum_{j=I} r_j^{t=1}} + e^{\sum_{j=I} r_j^{t=2}} + e^{\sum_{j=I} r_j^{t=3}} + e^{\sum_{j=I} r_j^{t=4}} + e^{\sum_{j=I} r_j^{t=5}}} \quad (3)$$

Because contestants do not know the independent observer's evaluations, they try to increase their chances to win according to this function.

Given h^{t-1}, the game from stage t on is denoted with $G(h^{t-1})$. When the actions chosen from stage t on are $((r_1^t, r_2^t, r_3^t, r_4^t, r_5^t), \ldots, (r_1^5, r_2^5, r_3^5, r_4^5, r_5^5))$, or in simpler terms $r^t, \ldots, r^5$, the final history would be $h^5 = (h^{t-1}, r^t, r^{t+1}, \ldots, r^5)$. Therefore, the final payoff for contestant i is $u_i(h^5)$.

For each contestant i, define the restriction of s_i to the histories consistent with h^{k-1} as $s_i \mid h^{k-1}$.

Definition (Fudenberg & Tirole, 1991): s is a subgame perfect equilibrium if $s \mid h^{k-1}$ is a Nash equilibrium of $G(h^{k-1})$.

Proposition: A strategy profile where $r_i^t \in \{3, 4, 5, 6\}$ for t≠i, $r_i^{t=i} = 0$, and $r_i^t \neq r_j^t$ for any t ∈ {1, 2, 3, 4, 5} and any two i, j ∈ I is a subgame perfect equilibrium.

This proposition results in two claims;

Claim 1: All contestants use the minimum grade they have.

Claim 2: Given the first claim, the same grade should not be used by different contestants on the same day.

The inevitable part of the proof is that rational contestants choose the least grades among the set {3, 4, 5, 6, 7, 8, 9, 10}. That grading a contestant with a higher point while having a lower one decreases the contestant's probability to win. Thus, through the week, contestants select among {3, 4, 5, 6}.

The second part of the proof is that different contestants do not use the same grades for a given day. Consequently, each contestant gets a total of 18 and has the same probability of winning. The equilibrium that has the best probability of winning occurs under a tie.

It is demonstrated that any deviation by a single contestant from the suggested equilibrium strategy profile would strictly decrease the payoff of that contestant. This deviation also creates an overlap of the grades for some contestants.

Suppose h^{t-1} is such that contestants have played the equilibrium strategies up to and including stage (t-1). If contestant i deviates from the equilibrium strategy starting from stage t on, the sum of points that contestants j ∈ {t, t+1, …, 5} collect is at least 18 x (5-t+1). If this had not been the case, this sum is exactly 18 x (5-t+1) under the equilibrium strategy profile.

Proof:

Without loss of generality, assume contestant 1 deviates from stage t on. Let the total points that contestants 4 and 5 collect be $\hat{R}_4 = \sum_{j=I} \hat{r}_j^4$, $\hat{R}_5 = \sum_{j=I} \hat{r}_j^5$, where $\hat{r}_j^4$, $\hat{r}_j^5$ denote the scores assigned to contestant 4 and contestant 5 under the deviation. Note that $R_1 = R_2 = R_3 = 18$ because of the assumed equilibrium for the first three stages.

Since $\hat{R}_4 + \hat{R}_5 \geq 18x2$, the final payoff for contestant 1 would be $(e^{18}/(e^{18} + e^{18} + e^{18} + e^{\hat{R}_4} + e^{\hat{R}_5}))$. This is maximized when $e^{\hat{R}_4} + e^{\hat{R}_5}$ is minimized. Now, consider the following problem and its equivalents;

$$\min e^{\hat{R}_4} + e^{\hat{R}_5} \text{ s.t. } \hat{R}_4 + \hat{R}_5 \geq 18x2 \quad (4)$$

$$\min e^{18}(e^x + e^y)\ s.t.\ x + y \geq 0 \quad (5)$$

$$\min e^x + e^y\ s.t.\ x + y \geq 0 \quad (6)$$

$$\mathcal{L} = e^x + e^y\ - \lambda(x + y) \quad (7)$$

FOCs;

$$e^x - \lambda = 0, \quad (8)$$

$$e^y - \lambda = 0. \quad (9)$$

So, it is concluded that x = y = 0.

Therefore, $\hat{R}_4 = \hat{R}_5 = 18$, but this is only possible under the suggested equilibrium profile, given $R_1 = R_2 = R_3 = 18$. ■

In Table 1, the situation is illustrated in numbers to clarify. “B”s represent the brides who cook while “P”s represent the mothers-in-law who grade. They can be considered the same, but it is written separately to make it clear who grades. The independent observer’s effect is not considered here since the contestants do not know the observer’s grade until all the grades are revealed. In other words, they only

observe each others' grades and then choose what to do next. So, the independent observer's grade is not included in the model itself, but it takes place in the analysis. Observer's grades affect all contestants; however, they are not aware of the situation. Therefore, they try to collect as many points as possible from the other contestants and grade them as low as possible in return so that their chance to win the game is higher. In this perspective, it is shown that each contestant uses {3, 4, 5, 6} with no points crossing with each other on any day and there is no intention to deviate as the equilibrium suggests. The sample grading scheme below is only one of those possibilities. Suppose that the history of three days is known where all contestants use the equilibrium strategies on these days. Table 1 shows the case that contestants use the suggested equilibrium strategies whereas Table 2 depicts the deviation. In the deviation case, on day four, P_1 changes her strategies of day four and day five, given the history of three days.

Table 1. Sample Equilibrium Grading Scheme from {3, 4, 5, 6} Given the History of Three Days

	B_1	B_2	B_3	B_4	B_5
P_1	x	6	5	4	3
P_2	3	x	6	5	4
P_3	4	3	x	6	5
P_4	5	4	3	x	6
P_5	6	5	4	3	x
Total	18	18	18	18	18

Table 2. Deviation of P_1 From the Equilibrium for Table 1

	B_1	B_2	B_3	B_4	B_5
P_1	x	6	5	3	4
P_2	3	x	6	5	4
P_3	4	3	x	6	5
P_4	5	4	3	x	6
P_5	6	5	4	3	x
Total	18	18	18	17	19

In Table 1, P_1 gets a probability of $\frac{e^{18}}{e^{18}+e^{18}+e^{18}+e^{18}+e^{18}} = 0.2$. On the other hand, if P_1 changes her grades for P_4 and P_5, she gets $\frac{e^{18}}{e^{18}+e^{18}+e^{18}+e^{17}+e^{19}} = 0.16$. Since P_1's probability of winning decreases in the second case, she would not deviate. In other words, the situation where different contestants use the same points for the same contestant is not equilibrium.

In this game, a contestant's strategy is to not use the same grade as another contestant on the same day. In the course of events, the strategies diminish since contestants are not able to use the same point twice and also, they observe other contestants' actions. Using the lowest grades, observations, and coordination among the contestants lead them to the equilibrium strategies. Strategies are from the set {3, 4, 5, 6} and are decided according to the process of the game. Besides, it decreases through the rounds since the set narrows down.

CHAPTER 5

DATA

Data is collected from a TV show named “Zuhal Topal’la Sofrada” that broadcasts on the local channel FOX TV in Turkey. Each program is on the channel’s website and YouTube. The show has three seasons. The new rule mentioned in the previous chapter is implemented in season two and in season three. The old rule was valid until the first four weeks of season two. The monetary reward is the same for season two and season three. The analysis is based on the new rule.

The main data for the analysis is for 74 weeks/sessions and 370 days of the program (programs 231-600). These programs took place between September 2019 and May 2021. Two weeks are eliminated due to the disqualification of the contestants, namely, week 3 and week 69. So, it is analyzed as 360 days/rounds. In other words, there are 72 weeks and 360 contestants in the data which leads to 1800 observations. 36 weeks of the data belong to season two and the other 36 weeks are from season three.

The show is held in the same residence for a while because of the pandemic. 44 weeks of the show was in that house while contestants cook at their own houses for 28 weeks (except for disqualifications). Another change is that contestants cook a mandatory meal for each week with season three.

After excluding the disqualifications from the data, the outliers who gave 10 points are eliminated to have a better understanding for some analysis. The data is analyzed using Stata. However, there is a limitation of this study. It is assumed that people are rational, notwithstanding this assumption may not hold in reality.

In terms of behavioral analysis, this paper analyzes whether people act rationally. Deviations from rationality in contestants' behavior are explained by reciprocity. Contestants might think that if they use a slightly higher point, they will get a higher point, as well. In other words, some contestants may avoid from giving the equilibrium points with the hope of getting at least the same in return. The reverse can also be an issue. For instance, contestants may give lower points to the contestants who have already given them a low point. The grading trend in the contest is shown by using STATA.

CHAPTER 6

RESULTS

The contest is explained, and the model is created in the previous chapters. This chapter analyzes the collected data to assess whether the symmetric equilibrium actualizes in this real-life example.

To clarify, descriptive statistics of the variables are examined. Table 3 shows the mean, standard deviation, median, minimum, and maximum values of the points given by the contestants, total points given by the opponents, the independent observer's point, contestants' overall points including the independent observer's points, if the contestants cook first, second, third, fourth, or fifth, and if they are already cooked. The mean and medians are close for all variables.

"Points" is the dependent variable which shows contestants' points towards the cooks. Considering that using one and two are forbidden and incomplete meals are very rare, its distribution is skewed to the right. This result is the opposite of what Schüller et al. (2014) suggested. Even though the points are not revealed there, people tend to use higher points. One might have expected that with the revelation of the points, reputation should have been more important here. However, contestants are more concerned about winning the game.

The other difference is the existence of an independent observer which is shown as "independent" in Table 3. She uses much higher points compared to the contestants. Moreover, she has not used less than three points.

In Table 3, the variable "total" represents the total points given to the cooks by the contestants. On the other hand, the variable "overall" shows the sum of total

and the independent observer's points. The winner is determined by looking at the "overall" points.

In addition to the main variables, some others are created. In the regression analysis, the impacts of "cook_second", "cook_third", "cook_fourth", "cook_fifth" are taken into consideration which represent cooking second, third, fourth, and fifth, respectively. In other words, if a contestant cooks on Monday, she cooks first. In the data, cooking first is indicated with one and others zero for this contestant. These are included in the descriptive statistics but do not reveal much data since they are binary variables. Thus, the points related to them are included to get a clear insight. To give an example, "point1" shows points given to contestants who cook first, and so on. Similarly, there is another binary variable called "already_cooked". This takes value one if the contestant has cooked and gives points to others. It takes zero if the contestants have not cooked, yet. To be more specific, in Table 3, the points given to contestants who already cooked are included by the variable "already".

These described variables indicate that those who cook first have a relatively lower mean and those who cook second have a higher mean than others. In addition to that, first day cooks did not get higher than 8. So, it is inferred that it is skewed to the right more than others. Table 3 shows that those who cook on Mondays are disadvantageous. This was also a finding of Schüller et al. (2014) paper. More detailed graphs to examine this are included later in this chapter. Another crucial point is that second day cooks got neither the highest nor the lowest, yet their mean is the highest. Except for the sharp increase in "point2", means gradually increase towards week. Schüller et al. (2014) also consider the number of ingredients as an indicator of difficulty. However, the difficulty of a meal should not be measured only

with the ingredients. Not only it does not reflect the difficulty but also contestants look for other things such as the taste, the effort to cook, etc.

Table 3. Descriptive Statistics

	Mean	SD	Median	Min	Max
points	4.9	1.579402	5	1	10
total	19.6	4.091233	20	7	32
independent	6.677778	1.340586	7	3	10
overall	26.27778	5.013662	27	11	40
cook_first	0.2	0.400112	0	0	1
cook_second	0.2	0.400112	0	0	1
cook_third	0.2	0.400112	0	0	1
cook_fourth	0.2	0.400112	0	0	1
cook_fifth	0.2	0.400112	0	0	1
already_cooked	0.4	0.490034	0	0	1
point1	4.732639	1.154318	5	1	8
point2	5.013889	1.306569	5	2	9
point3	4.784722	1.463437	5	1	10
point4	4.975694	1.74191	5	1	10
point5	4.993056	2.054981	5	1	10
already	4.805556	1.801243	5	1	10

In Table 3, all data except disqualifications are included. As the general rule, contestants should use 3 or higher. However, they have the right to use one or two if at least one meal is incomplete. Less than three points are used only 40 times out of 1440 points which is 2.78% of the total given points as seen in Table 3. Thus, the skewness comment above is not affected by incomplete meals that much.

Table 4 and Table 5 show the distribution of points given by the contestants and the independent observer's points for the contestants, respectively. Ignoring the rare occurrence of using one and two, Table 4 displays that the points given by the contestants concentrate mainly on three, four, five, and six. Points that are more than six compose only about 14% of all points given by the contestants.

Table 4. Distribution of Points Given by the Contestants

Points	Freq.	Percent	Cum.
1	10	0.69	0.69
2	30	2.08	2.78
3	259	17.99	20.76
4	315	21.88	42.64
5	324	22.50	65.14
6	302	20.97	86.11
7	134	9.31	95.42
8	32	2.22	97.64
9	17	1.18	98.82
10	17	1.18	100.00
Total	1440	100.00	

It is already indicated that the independent observer has not used less than three points. Her points center around five, six, seven, and eight, as seen in Table 5. She is thought more equal compared to the contestants. Contrarily, contestants tend to give the lowest possible points as expected. Moreover, this shows that reputation is not that important for the contestants differing from Schüller et al. (2014).

Table 5. Distribution of Points Given by the Independent Observer

Points	Freq.	Percent	Cum.
3	5	0.28	0.28
4	40	2.22	2.50
5	340	18.89	21.39
6	495	27.50	48.89
7	365	20.28	69.17
8	390	21.67	90.83
9	150	8.33	99.17
10	15	0.83	100.00
Total	1800	100.00	

Figure 1 shows the mean of total points for all contestants. As mentioned earlier, total is calculated by summing the points given to the cooks except for the independent observer. Figure 1 depicts that contestants who cook on day one have the least average total points among all the cooks. Third day cooks follow with a

slightly higher average. Additionally, day two cooks have the highest mean of total points. This also implies that those who cook on Mondays are disadvantageous and have less chance to win by the occurrence of the points. This was also the case for "Come Dine with Me". However, here, the independent observer has also an effect on determining the winner. Thus, the contestants know that their points alone are not enough to be the winner. The independent observer's points are not included in the graphs or the histograms, but the comparison of the total points and the overall points are included later on this chapter.

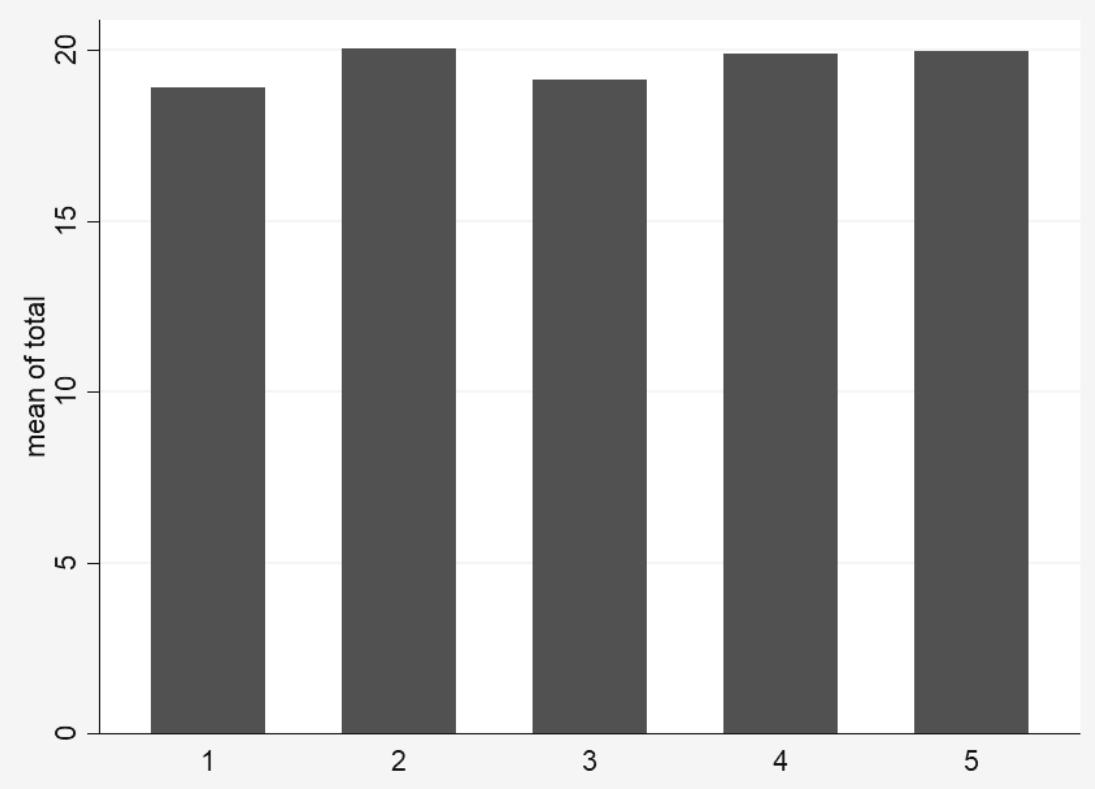

Figure 1. Mean of total points over cook

Another significant issue is to understand the rationale behind the evaluations. Figure 2 composes the contestants' points given to the cooks through the week. Each graph in Figure 2 indicates one contestant. The missing columns show who is grading since nobody gives points to themselves.

There are two observations related to that. A familiar one is that the mean of points are higher for day two cook. Nevertheless, those who cook on day one grade the second cook lowest on average. Another remarkable point is that contestants tend to give higher points to the cook who competes the day before them. In terms of k-level thinking, 0 degree is giving the points randomly, and 1 degree would be giving the highest point to the immediate predecessor. Besides, day one cooks' behavior implicate that the contestants have a short term memory since they give their lowest points on average to the second day contestants, even though day two cooks use their higher points for day one cooks. Another implication of the short term memory is that day five cooks get higher points from those who cook on day one.

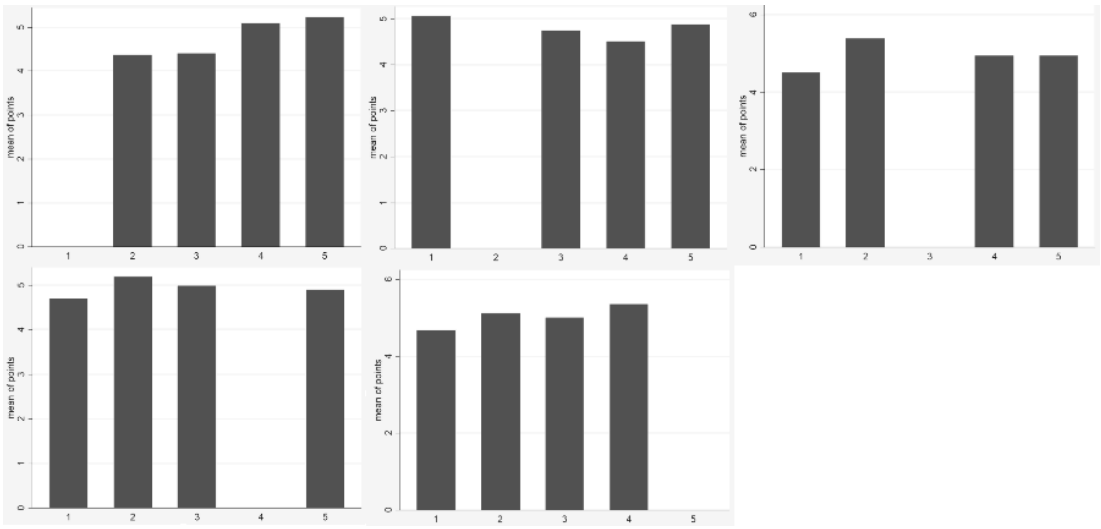

Figure 2. Mean of given points by the contestants over cooks

Below, there are several histogram graphs. In Figure 3, the graph is by cook. In Figure 4, the graph is by "already_cooked". This consists of the contestants who already cooked in the day of evaluations. It is equal to zero for the contestants who cook later, and it takes value one otherwise. Finally, Figure 5 is constituted by received points. In Figure 5, the points {1, 2, 10} are excluded since they are outliers.

In the latter, the points given are compared to the received points of the contestants. These three histogram graphs draw a picture about the behaviors of the contestants.

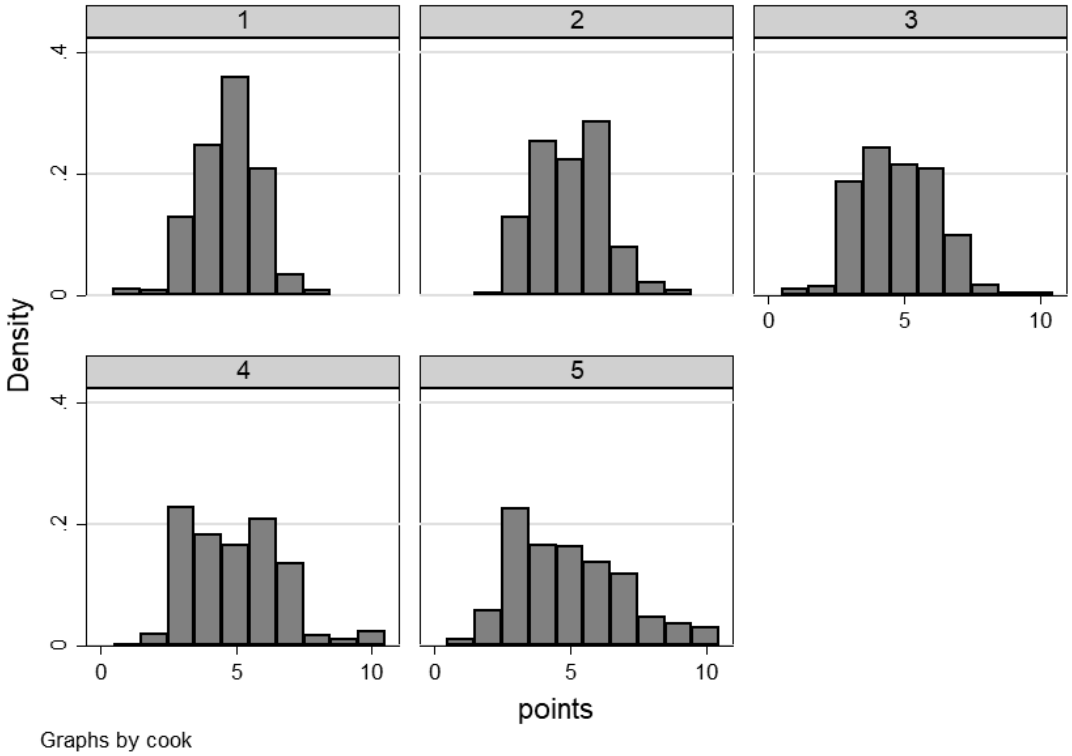

Figure 3. The histogram graph of points by cook

In Figure 3, it is seen that day one cooks' grades are mostly on the left side. Moving to day five cooks, the right side appears more and more. This is because contestants lose their rationality as they get their grades. For instance, contestants who already cooked give fewer points to other contestants that gave them those points. Moreover, they give more points, even {7, 8, 9, 10}, to the remaining contestants so that the low-point givers are punished. Another finding is that day two cooks' grades accumulate in the middle.

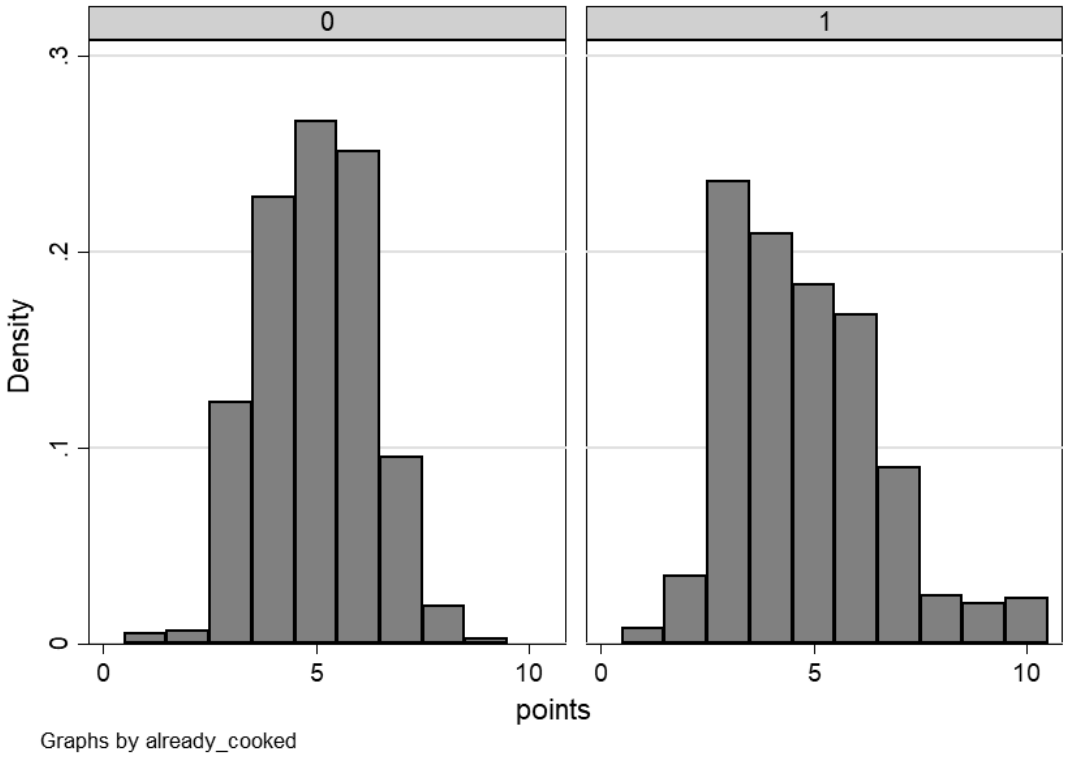

Figure 4. The histogram graph of points by contestants who already cooked

Figure 4 indicates that contestants that cook earlier assign lower points compared to the later. Contestants who cook later give slightly higher grades in expectation to get higher grades in return. In other words, later shows the people who have not cooked yet on the day of evaluation. On the other hand, the contestants who have cooked on the day of evaluations are indicated as “already_cooked”.

Finally, Figure 5 shows the density that contestants assign by their received grades. Here, “received” shows the points given to the contestants by their opponents and “points” indicates the points given by the contestants. Contestants that receive low grades such as three or four tend to assign lower grades. On the other hand, contestants that receive higher grades mostly give five points even though they get as high as eight. This means that the expected reciprocation does not take place.

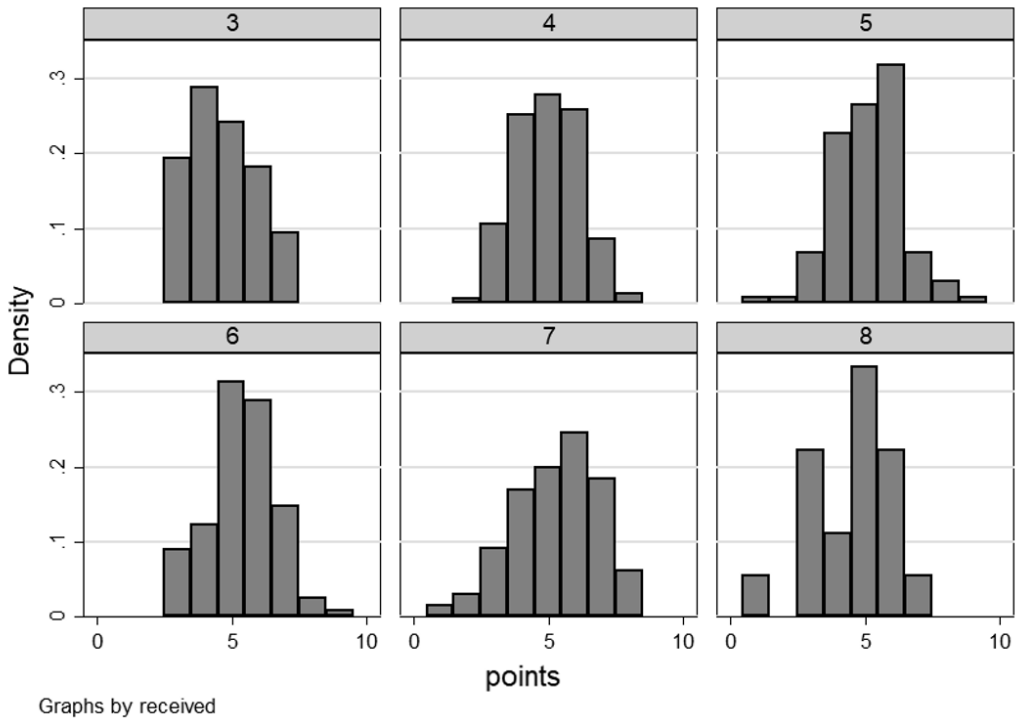

Figure 5. The histogram graph of points by received excluding the outliers {1, 2, 10}

Previous graphs implicate that contestants who cook on day one have lower grades compared to the other contestants. In Table 6 and Table 7, the total grades of contestants are seen with and without the grade of the independent observer, respectively. “Highest” show the contestants who get a highest total because of other contestants’ grades. On the other hand, the winner is determined after the evaluations of the independent observer.

Table 6. The Distribution of Highest Total Grades

Bride	Highest		Total
	0	1	
1	65	7	72
2	50	22	72
3	55	17	72
4	55	17	72
5	55	17	72
Total	280	80	360

Table 7. The Distribution of Winners

Bride	Winner		Total
	0	1	
1	60	12	72
2	55	17	72
3	60	12	72
4	56	16	72
5	54	18	72
Total	285	75	360

From a total of 360 contestants, first day cooks only get the highest total seven times while second day cooks have the highest 22 times. Overall, there are eight ties in the first one and three in the latter. Besides, a balanced distribution of winners is seen among contestants. The importance of the independent observer's point is seen in Table 7. She has an undeniable effect on determining the winner.

To analyze what affects the way contestants grade each other, a regression analysis is performed. The effects of the independent variables on the "points" are analyzed using the OLS model.

In Table 8, the regression results which are a duplication of Schüller et al. (2014) are observed, although, the independent observer is included as an independent variable in the analysis. Therefore, this paper looks at the effects of cooking second, cooking third, cooking fourth, cooking fifth, those who already cooked, and the independent observer (namely, "independent") on the points given by the contestants. After looking at the results, the conclusions are compared with Schüller et al. (2014). The regression is clustered across week and the equation can be stated as:

$$points_{ijw} = \beta_0 + \beta_1 cook\_second_{iw} + \beta_2 cook\_third_{iw} + \beta_3 cook\_fourth_{iw} + \beta_4 cook\_fifth_{iw} + \beta_5 already\_cooked_{jw} + \beta_6 independent_{iw} + \varepsilon_{ijw}$$

In this regression βs are the coefficients and ε demonstrates the error term. The index "i" represents the cooks and "j" represents the contestants that give points, while "w" shows the weeks of the show. More specifically, "cook_second" represent those who cook on Tuesdays, "cook_third" represents those who cook on Wednesdays, "cook_fourth" represents those who cook on Thursdays, and "cook_fifth" represents those who cook on Fridays. Additionally, the independent observer is shown as "independent". These are indexed with "iw" which means they alter between the weeks for the cooks. The ones indexed with "ijw" change across both the cooks and the evaluators for different weeks. Hence, the error term and the dependent variable "points" are indexed with "ijw". On the other hand, the variable "already_cooked" is equal to one for the contestants that have performed on the day of evaluations. This varies across the evaluators within weeks.

Table 8. The Regression Results of OLS Model

	Coef.	Std. Err.
cook_second	0.526*	0.112
cook_third	0.453*	0.136
cook_fourth	0.62*	0.152
cook_fifth	0.735*	0.155
already_cooked	-0.57*	0.075
independent	0.461*	0.049

Note. *p<0.01; robust standard errors (clustered by week)

Table 8 shows the regression results. The effects of cooking increase as it goes through the week which means the order of cooking is important. On average, a contestant who cooks fifth gets 0.735 more than a contestant who cooks first, which is a great advantage to the one who cooks later. Once more, it shows how disadvantageous Monday contestants are. This may be because of their lack of knowledge on day one. Neither the evaluators know anything about the cook or other contestants, nor does the cook know her guests.

Another significant factor is that a contestant gives 0.57 points less on average if that person already cooked compared to the one who has not cooked yet. In the literature, this trend is explained by overestimating their performances. This may be one of the reasons for this contest. Contestants who already cooked usually indicate that the meal that comes after their days are not that good. In addition, another behavioral factor might apply here. Those who have not cooked might give higher points with the hope of getting higher points. Thus, those who already got high points may respond with lower points compared to them.

Finally, the independent observer "independent" has a positive impact on the points. For an additional point she gives, the point of the cook rises by 0.46 on average. The findings are similar to what Schüller et al. (2014) depicts. However, the effects are more explicit in the analyzed contest.

CHAPTER 7

CONCLUSION

In this paper, symmetric equilibrium in a zero-sum, single-act, dynamic game design where contestants simultaneously act is studied. The game is based on a TV show, and the data is taken from “Zuhal Topal’la Sofrada”. It is a cooking contest where one contestant cooks each day. Later, the other four contestants give points to the cook simultaneously and reveal their points. From day one to day five, contestants’ strategy sets decrease, and information sets expand. This is due to the fact that contestants are not able to use the same point more than once as a rule, and they reveal the points at the end of each day. Besides, they are not able to use less than three for a complete dinner table. These features differ from the previous similar show “Come Dine with Me”. These differences make a contribution to the existing literature since it reaches to a different equilibrium.

The equilibrium for this multiple-staged contest is associated with MSG with observed actions, using SPE. In consideration of the symmetric equilibrium, it is analyzed whether this corresponds to the received data. Two significant claims are proved after this paper. First one is that contestants use their lowest grades through the week. This results in using a point from the set {3, 4, 5, 6} considering the record of the game at each stage. The other one is that their points for a particular contestant should not overlap. Nobody tends to deviate from the suggested equilibrium.

After the theoretical part, the data shows what people are expected to do in real-life. In this part, it is found out that contestant one receives the lowest grades usually, and contestant two has the highest. On the other hand, the independent

observer balances these differences since she evaluates objectively. This is also new in the literature with this contest. Contestants increase their probability of winning with the points they give. Even though they do not have the highest total, they still are able to win considering the evaluation of the independent observer. It is also indicated that both the order of cooking and having already cooked significantly affect the points that contestants get. Additionally, contrary to "Come Dine with Me", contestants indeed use their lower points. This depicts the most significant difference from the other show.

The focus of this paper is to figure out the behavioral effects in a contest. There is a complicated question: "Do people act rationally or do they have behavioral concerns?". To some extent, the contest reflects the society and helps to understand people's behaviors when faced with a monetary reward.

In the creation of the model and the strategies, this paper includes only the points of other contestants since it is the only observable value. However, beliefs can be added to the strategy. To illustrate, the cheap talk during the dinner can be used to form the beliefs about their points. In the future work, strategies that include this belief might contribute to what this paper suggests.

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