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Abstract

We interpret the TV-show *Come Dine with Me* as a simultaneous non-cooperative game with evaluation levels as strategic variables, and show that it belongs to a class of strategic games which we label *mutual evaluations games* (MEG). Any MEG possesses a 'zero equilibrium'—i. e. a Nash equilibrium where all players evaluate each other with the lowest available scores — as well as numberless 'non-zero equilibria'. Since the former is an equilibrium in weakly dominant strategies, it may arguably be regarded as a focal point. Yet, in 212 rounds of the German format of *Come Dine with Me* contestants never got to this focal point, nor did they (with one exception) play any other equilibrium. We provide potential explanations for this off-equilibrium behaviour by considering the impact of social pressure and reputation mechanisms, bandwagon effects, inequality aversion and sequential voting effects.

JEL-Code: C720, D030.

Keywords: non-cooperative game, aggregative game, Nash-equilibrium, focal point, Come Dine with Me, mutual evaluation game, other regarding preferences, sequential voting effect.

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1. Introduction

Since its first broadcasting in 2005, the British TV-Show *Come Dine with Me* gained great popularity and is well established by now. Today, identical or very similar formats of the show are televised in 32 countries world-wide,[1] and often reach a quite remarkable number of viewers, as for example in Germany, Turkey and Israel.[2] In this show, four or five amateur chefs take turns in cooking and hosting a dinner party for each other during the course of a week. All contestants have to announce their menu before the first dinner, and cannot change it afterwards. After each dinner night the performance of the chef is evaluated by his contenders on a scale from 0 to 10, with 10 representing the highest score. The individual evaluations remain undisclosed until the show is eventually broadcast (several weeks or months later). The contestant with the highest cumulative score is the winner and obtains the cash prize of £1,000. If several contestants receive the same score the prize is split equally among those. Irrespective of the outcome of the contest, every contestant receives the same fixed amount to cover cooking and travelling expenses.

Although *Come Dine with Me* is a very popular TV-format, there are only few studies that investigate the strategic and behavioural aspects of this show. Notable exceptions are Haigner et al. (2010) who consider sequential position effects in the German version. These authors find that a negative position effect exists for the first competitor. Moreover, Ahmed (2011) compares the means of points given in the Swedish version of the show, and finds no significant differences between voting behaviour of men and women. While there is apparently little research on *Come Dine with Me*, there is a growing literature on other TV-formats exploring these shows from a behavioural point of view.[3] Yet, the format which resembles most closely the *Come Dine with Me* setting, namely *Big Brother* has neither been investigated in a rigorous economic fashion. *Big Brother* is similar to *Come Dine with Me* as contestants' voting behaviour is anonymous for the other contestants but public to the television viewer. Furthermore, contestants may vote each other out of the game, and the winner is paid a cash prize at the end of the show. In view of the sparse economic literature on this type of a TV show, we explore the game-theoretic aspects of *Come Dine with Me* and provide potential explanations why contestants may not end up in a Nash equilibrium.

Since individual evaluations remain undisclosed until the show is broadcast, participants do not know the evaluations received by antecedent chefs, and can thus not

[1]For example, the German format is called *Das perfekte Dinner* (since March 2006); the French, *Un Dîner Presque Parfait* (since February 2008); the Turkish, *Yemekteyiz* (since October 2008) etc.

[2]See, for example, http://en.wikipedia.org/wiki/Come_Dine_with_Me.

[3]See for example Bennett and Hickman (1993); Berk et al. (1996); Anwar (2012); Page and Page (2010); van den Assem et al. (2011).

condition their evaluations on past voting behaviour of their competitors. With this lack of information, evaluations are made as if they had been chosen simultaneously. For this reason, we may interpret the choice of mutual evaluations as a strategic game played simultaneously by five players (contestants) each of which selects a score vector of length four with elements between 0 and 10, representing the respective evaluations of the other players.[4] Since for each player the chances of winning are increasing in his own total score but decreasing in the total score of his contenders, the payoff of a player is non-increasing in the evaluations attributed to either of his competitors. Consequently, it is not in a player's interest to award some other player some positive score.

Thus, if contestants are solely interested in their own payoff without any fairness considerations or social preferences, one would expect contestants to rate each other with zero scores, as this would not only serve to minimize the chances of winning for the other contestants, but can also be achieved at zero (pecuniary) cost for the evaluating player. Furthermore, the evaluator does not have to fear punishment from his peers, since his voting behaviour is unobservable while the voting process continues, but is observable by the public upon broadcasting later. However, although there is neither the possibility of punishment nor even of identification during the game, zero evaluations are very rarely observed in the show. For this reason we have to look for possible explanations for off-equilibrium behaviour of contestants.

Correspondingly, this paper serves a threefold task. Firstly, we define a class of games, the class of *mutual evaluation games (MEG)*, and show that *Come Dine with Me* belongs to this class. Secondly, we explore the Nash equilibria of this class of games, and demonstrate that any MEG, and therefore *Come Dine with Me* in particular, has a unique Nash equilibrium in weakly dominant strategies where each player chooses an evaluation vector with all elements equal to the lowest possible evaluation level, which equals zero in the case of *Come Dine with Me*. That is, in this equilibrium all players evaluate all other players with zero scores, and we therefore refer to this equilibrium as the *zero equilibrium* henceforth. In addition, any MEG has numerous other (weak) Nash equilibria with non-zero evaluation profiles. Yet, due to the apparently salient features of the *zero equilibrium* — an equilibrium in (weakly) dominant strategies and choices of polar strategies — this equilibrium may be regarded as a *focal point*, as first discussed by Schelling (1960) for coordination games: In games with multiple equilibria contestants expect each other to behave in a specific fashion even though no communication on strategies to be followed is possible, and in this sense all players focus on a specific equilibrium: the focal point.

[4]We exclusively focus on the evaluation part of the show, taking the menu setting strategy as exogenous. This restriction of the strategy space seems to be appropriate as the menu has to be chosen in advance, in a situation of complete ignorance, and without any commitment for the subsequent evaluation game.

Finally, we indicate possible explanations why in actual shows contestants typically do neither play the *zero equilibrium* nor end up in any other Nash equilibrium. This phenomenon may be attributed to social or behavioural aspects, some of which we then discuss. Also, our discussion points upon potential directions for future research on contestants' actual behaviour in TV shows, or more broadly, on the behaviour in publicly observed games of the MEG class.

The rest of the paper is structured as follows. In Section 2 we define the MEG class and formalise the show *Come Dine with Me* as such a strategic game. In Section 3 we characterise the Nash equilibria of a MEG, and in particular of *Come Dine with Me*. Subsequently, in Section 4 we describe observed behaviour of contestants in actual shows and then provide possible explanations for why contestants fail to achieve some Nash equilibrium. Finally, we provide some concluding remarks in Section 5.

2. The Model

In this section we formally introduce a class of strategic games called *mutual evaluation games (MEG)*, and then show that the game *Come Dine with Me* belongs to this class. Also, we argue that a MEG is a special type of an aggregative game.

We use the following notation. $N := \{1, 2, \dots, n\}$ denotes the set of players. (For *Come Dine with Me* we have $n = 5$.) In this game, each player assigns to each other player an evaluation or score, represented by a natural number between 0 and k (for *Come Dine with Me* k equals 10).[5] However, a player may not evaluate herself, which is formally captured by requiring player i to assign to herself the minimum evaluation level, *i. e.* a zero score. Accordingly, the strategy set of player i, $i \in N$ is given by

$$S^i := \{\mathbf{s} \,|\, \mathbf{s} = (s_1, \dots, s_n)^\mathsf{T},\ s_j \in \mathbb{N}_{(k)} \text{ for } j \neq i, \text{ and } s_i = 0\},$$

where $\mathbb{N}_{(k)} := \{0, 1, \dots, k\}$ represents the set of natural numbers up to k, $k \in \mathbb{N}$. Note carefully that a strategy (or action) of each player is not a scalar but an n-dimensional vector: a strategy $\mathbf{s}^i$ of player i consists of n evaluations $s^i_j \in \mathbb{N}_{(k)}$, one for each player $j \in N$, including the (notional) self-evaluation $s^i_i \equiv 0$.

While $\mathbf{s}^i$ denotes some n-dimensional strategy of player i, we write $\mathbf{S} := (\mathbf{s}^1, \dots, \mathbf{s}^n)$ for the n-tuple of n-dimensional strategies, so that $\mathbf{S}$ may be identified with the matrix

$$\mathbf{S} = (\mathbf{s}^1, \dots, \mathbf{s}^n) = \begin{pmatrix} s^1_1 & \cdots & s^n_1 \\ \vdots & & \vdots \\ s^1_n & \cdots & s^n_n \end{pmatrix},$$

[5]More generally we could allow for the set of possible evaluation values to be some closed subset of $\mathbb{R}_+$. Yet for the sake of tangibility, we prefer to present our results for a finite set of evaluation values, with 0 representing the lowest evaluation score; the generalisation to some arbitrary closed set is straightforward, though.

where all diagonal elements of $\mathbf{S}$ equal zero, *i. e.*, $s_i^i = 0, \forall i \in N$. Note that the i–th column of $\mathbf{S}$ represents the strategy of player i, while the i–th row of $\mathbf{S}$ represents the evaluations *received* by player i. Accordingly we may denote by $\mathbf{p} := \sum_{j \in N} \mathbf{s}^j$ the vector of total valuations received by (and from) all players; and by $\mathbf{p}^{-i} := \sum_{j \neq i} \mathbf{s}^j$ the vector of total valuations received *from* all players but i. Observe that $\mathbf{p} = \mathbf{S} \cdot \mathbf{e}$, where $\mathbf{e} := (1, \ldots, 1)^{\mathsf{T}}$, so that $\mathbf{p}$ is a linear function, *viz* the sum, of the strategies $(\mathbf{s}^1, \ldots, \mathbf{s}^n)$.[6]

Come Dine with Me is, as well as any game of the class we are considering, a the-winner-takes-it-all contest where the prize v ($v \in \mathbb{R}_+ \setminus \{0\}$) is assigned to the player who receives the highest total evaluation; with a symmetric tie-breaking rule, that is, in case of a tie the prize is split equally among the winners.[7] Let $\bar{p}(\mathbf{S}) := \max\{p_1(\mathbf{S}), \ldots p_n(\mathbf{S})\}$ denote the maximum total evaluation received by some player for valuations $\mathbf{S}$; and let $W(\mathbf{S}) := \{j \,|\, p_j(\mathbf{S}) = \bar{p}(\mathbf{S})\}$ denote the winning players (players with maximal total evaluations) under $\mathbf{S}$. Using the symbol $\mathbb{1}$ to denote the indicator function, the payoff of player i is defined by the payoff function

$$u^i : \bigtimes_{i \in N} S^i \to \mathbb{R}_+ \quad : \quad \mathbf{S} \mapsto u^i(\mathbf{S}) = \mathbb{1}_{\{p_i(\mathbf{S}) = \bar{p}(\mathbf{S})\}} \frac{v}{|W(\mathbf{S})|},$$

and the payoff vector $\mathbf{u}(\mathbf{S}) \equiv (u^1, \ldots u^n)(\mathbf{S})$ is defined accordingly. — With these elements at hand, we can now define the class of games we wish to work with.

Definition 1. *A strategic form game* Γ *of the form* $\Gamma = \langle N, (S^i)_{i \in N}, (u^i)_{i \in N} \rangle$ *with*

- *a non-empty, finite set of players* N,
- *a collection of (n-dimensional) non-empty strategy sets* S^i
- *and a collection of payoff functions* u^i *(together with a positive prize* z*),*

as defined above, is called a mutual evaluation game (MEG).

Obviously, the game *Come Dine with Me* is a MEG with $n = 5$, $k = 10$ (that is, with $k + 1 = 11$ evaluation levels) and $v = 1000$£.

Observe that an evaluation game has a special feature: The payoff of each player depends only on the *total* scores of all players, *i. e.* on the vector $\mathbf{p} = \mathbf{S} \cdot \mathbf{e}$, but not single scores, collected in matrix $\mathbf{S}$. Accordingly, the payoff of player i can be written as a function of her own strategy $\mathbf{s}^i$ and of the *sum* of the strategies of the other players, $\mathbf{p}^{-i}$ or, more precisely, $\mathbf{p}^{-i}(\mathbf{S}^{-i})$:

$$u^i(\mathbf{S}) = u^i(\mathbf{s}^i, \mathbf{S}^{-i}) =: \tilde{u}^i(\mathbf{s}^i, \mathbf{p}^{-i}),$$

[6] More formally, $\mathbf{p}$ may be defined as the linear function $\mathbf{p} : \mathcal{M}(n, n, \mathbb{N}_{(k)}) \to \mathbb{N}^n_{(nk)} : \mathbf{S} \mapsto \mathbf{S} \cdot \mathbf{e}$, where $\mathcal{M}(n_1, n_2, \mathbb{N}_{(k)})$ denotes the set of $\mathbb{N}_{(k)}$-valued $n_1 \times n_2$–matrices.

[7] In *Come Dine with Me* the prize v equals 1000 £; in *Das perfekte Dinner*, 1600 EUR. However, we may consider any arbitrary but fixed amount $v > 0$.

where, with the usual sloppiness, we write $\mathbf{S} = (\mathbf{s}^i, \mathbf{S}^{-i})$. Due to this feature, *Come Dine with Me* is an (n-dimensional) *aggregative game* — and thus the results obtained in the literature for this type of a game apply here.[8]

In the next section we characterise the Nash equilibria of a MEG, and illustrate our result by means of three examples.

3. Nash-Equilibria of Mutual Evaluation Games

Since total valuation received by player i, p^i, is linearly increasing in the evaluations awarded to her by the other players, $\mathbf{s}_i \equiv (s_i^1, \dots, s_i^n)$ (i-th row of $\mathbf{S}$), the payoff of player i is weakly increasing in $\mathbf{s}_i$. In contrast, the payoff of player j is weakly decreasing in p^i ($i \neq j$) and thus in s_i^j — irrespective of the strategies chosen by the other players $\mathbf{S}^{-j}$. Consequently, for each player it is a weakly dominant strategy to evaluate all players at the lowest level available, that is at level zero, implying that $\mathbf{S} = (\mathbf{0}, \dots, \mathbf{0})$ constitutes a Nash equilibrium in weakly dominant strategies, with resulting payoffs $\mathbf{u}(\mathbf{0}, \dots, \mathbf{0}) = (v, \dots, v)/n$. However, there are also other, non-zero Nash equilibria, as the following simple example shows.

Example 1. Let $N := \{1, 2, 3\}$ (*i. e.*, $n = 3$), and let $S^i := \{\mathbf{s} \,|\, \mathbf{s} = (s_1, s_2, s_3)^\mathsf{T},\ s_j \in \mathbb{N}_{(1)}$ for $j \neq i$, and $s_i = 0\}$. Thus, each player has $|S^i| = 4$ strategies, for example, the strategy set of player 1 equals

$$S^1 = \left\{ \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix} \right\}.$$

This game has four equilibria:

$$\mathbf{S}_1^* = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad \mathbf{S}_2^* = \begin{pmatrix} 0 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad \mathbf{S}_3^* = \begin{pmatrix} 0 & 0 & 0 \\ 1 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix}, \quad \mathbf{S}_4^* = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 0 \end{pmatrix},$$

with total scores $\mathbf{p}(\mathbf{S}_1^*) = (0, 0, 0)^\mathsf{T}$, $\mathbf{p}(\mathbf{S}_2^*) = (2, 0, 0)^\mathsf{T}$, $\mathbf{p}(\mathbf{S}_3^*) = (0, 2, 0)^\mathsf{T}$ and $\mathbf{p}(\mathbf{S}_4^*) = (0, 0, 2)^\mathsf{T}$, and payoffs $\mathbf{u}(\mathbf{S}_1^*) = \frac{1}{3}(v, v, v)$, $\mathbf{u}(\mathbf{S}_2^*) = (v, 0, 0)$, $\mathbf{u}(\mathbf{S}_3^*) = (0, v, 0)$ and $\mathbf{u}(\mathbf{S}_4^*) = (0, 0, v)$.

The next example demonstrates that the number of equilibria rises quickly as we increase the number of evaluation levels, and thus the strategy set.

[8] For the theory of aggregative games, though with scalar strategies, see Corchon (1994) and Jensen (2010).

Example 2. This example extends Example 1 by allowing for three rather than two evaluation levels, *i. e.*, $S^i := \{\mathbf{s} \,|\, \mathbf{s} = (s_1, s_2, s_3)^\mathsf{T},\ s_j \in \mathbb{N}_{(2)}$ for $j \neq i$, and $s_i = 0\}$, where $\mathbb{N}_{(2)} := \{0, 1, 2\}$. Accordingly, each player has $|S^i| = |\mathbb{N}_{(2)}|^{(n-1)} = 3^2 = 9$ strategies. For example, the strategy set of player 1 equals

$$S^1 = \left\{ \begin{pmatrix}0\\0\\0\end{pmatrix}, \begin{pmatrix}0\\0\\1\end{pmatrix}, \begin{pmatrix}0\\0\\2\end{pmatrix}, \begin{pmatrix}0\\1\\0\end{pmatrix}, \begin{pmatrix}0\\1\\1\end{pmatrix}, \begin{pmatrix}0\\1\\2\end{pmatrix}, \begin{pmatrix}0\\2\\0\end{pmatrix}, \begin{pmatrix}0\\2\\1\end{pmatrix}, \begin{pmatrix}0\\2\\2\end{pmatrix} \right\}.$$

This game has 55 equilibria, which consist of 12 different types in the sense that permutations of the players "names" generate all of the 52 equilibria. These 12 types look as follows, assuming that player 3 is the winner of the contest.

$$\mathbf{S}^*_a = \begin{pmatrix}0&0&0\\0&0&0\\0&0&0\end{pmatrix}, \quad \mathbf{S}^*_b = \begin{pmatrix}0&0&0\\0&0&0\\1&1&0\end{pmatrix}, \quad \mathbf{S}^*_c = \begin{pmatrix}0&0&0\\0&0&1\\2&0&0\end{pmatrix}, \quad \mathbf{S}^*_d = \begin{pmatrix}0&0&0\\0&0&0\\1&2&0\end{pmatrix},$$

$$\mathbf{S}^*_e = \begin{pmatrix}0&0&0\\1&0&0\\2&1&0\end{pmatrix}, \quad \mathbf{S}^*_h = \begin{pmatrix}0&0&0\\0&0&0\\2&2&0\end{pmatrix}, \quad \mathbf{S}^*_j = \begin{pmatrix}0&0&0\\1&0&0\\2&2&0\end{pmatrix}, \quad \mathbf{S}^*_l = \begin{pmatrix}0&1&0\\1&0&0\\2&2&0\end{pmatrix},$$

$$\mathbf{S}^*_m = \begin{pmatrix}0&0&0\\0&0&1\\2&1&0\end{pmatrix}, \quad \mathbf{S}^*_p = \begin{pmatrix}0&0&0\\0&0&1\\2&2&0\end{pmatrix}, \quad \mathbf{S}^*_r = \begin{pmatrix}0&1&0\\0&0&1\\2&2&0\end{pmatrix}, \quad \mathbf{S}^*_s = \begin{pmatrix}0&0&1\\0&0&1\\2&2&0\end{pmatrix}.$$

These examples illustrate our results: Any mutual evaluation game possesses a Nash equilibrium in weakly dominant strategies where each player plays $\mathbf{s}^i = \mathbf{0}$; and we henceforth refer to this equilibrium as the *zero equilibrium*. Beyond this, any mutual evaluation game has many non-zero (weak) Nash equilibria, and their number grows rapidly in both the number of evaluation levels and the number of players. Moreover, for a non-zero tuple of strategies to constitute an equilibrium, the difference in total scores between any loser (non-winner) and some other player must be sufficiently large so as to guarantee that a loser cannot profitably deviate. For the same reason, in any non-zero equilibrium each winner evaluates all co-winners (split win) — if there are any — with a zero score. More formally we arrive at:

Proposition 1. *Any mutual evaluation game possesses a unique Nash equilibrium in weakly dominant strategies where each player plays* $\mathbf{s}^i = \mathbf{0}$ *(the* zero equilibrium*), with resulting payoffs* $u^i(\mathbf{S}) = v/n$*, and multiple non-zero, weak Nash equilibria. Any equilibrium is characterised by two conditions:*

(1) *Each winner assigns 0 to all other winners,* i. e., $s^i_j = 0, \forall i, j \in W(\mathbf{S})$.
(2) *For each loser i there is at least one other player j (who may be a loser or a winner) such that the difference between the total evaluations of j,* $p_j(\mathbf{S})$*, — which in case j happens to be a winner equals* $\bar{p}(\mathbf{S})$ *— and her own total*

evaluation, $p_i(\mathbf{S})$, exceeds the evaluation which i awarded to j, that is, $\forall i \in N \setminus W(\mathbf{S})$, $\exists j \in N : p_j(\mathbf{S}) - p_i(\mathbf{S}) > s^i_j$.

The first property guarantees that a winner cannot increase her payoff by reducing the number of co-winners. Consequently, there must be a unique winner, unless the mutual evaluations of all winners equal zero. Observe, though, that this does not rule out that there are two or more winners in equilibrium. The second property ensures that even if loser i considers to reduce her evaluations of (some or all) other players to zero, there is at least one player who still has total higher evaluation than player i — so that it does not pay for player i to deviate from her chosen strategy. The following example illustrates this.

Example 3. Consider the game *Come Dine with Me*, that is a MEG with $n = 5$ players and 11 evaluation levels, *i. e.*, $s^i_j \in \mathbb{N}_{(10)}$. Assume that total evaluations amount to $\mathbf{p}(\mathbf{S}) = (20, 28, 12, 29, 5)^\mathsf{T}$ — so player 4 is the unique winner. Consider player 1 with strategy $\mathbf{s}^1 = (0, 5, 3, 10, 1)^\mathsf{T}$. If player 1 reduces her award of player 4 to $\tilde{s}^1_4 = 0$, player 4 is no longer the winner of the game, and player 1 has a higher total evaluation than has player 4. Yet, player 1 still does not belong to the group of winners, for player 1 cannot avoid having a lower total evaluation than player 2 has (who is not a winner under $\mathbf{S}$ though). This is easily seen by subtracting the evaluations of player 1 from the total evaluations obtained by the players under $\mathbf{S}$: $\mathbf{p}(\mathbf{S}) - \mathbf{s}^1 = (20, 23, 9, 19, 4)^\mathsf{T}$. Accordingly, player 1 has no incentive to unilaterally deviate from her chosen strategy $\mathbf{s}^1$. — If a similar argument holds for the other players, $\mathbf{S}$ constitutes a (weak) Nash equilibrium.

4. Discussion of Observed Behaviour

In the previous section we have shown that the TV show *Come Dine with Me*, interpreted as a non-cooperative game in evaluation profiles[9], belongs to a class of games which we labelled *mutual evaluation games (MEG)*. Furthermore, any MEG, and the game *Come Dine with Me* in particular, possesss one Nash equilibrium in weakly dominant strategies, the so-called *zero equilibrium* where each player uses a vector of zero evaluations, and numberless weak Nash equilibria, where at least two players play non-zero strategy profiles. We now explore actual behaviour of participants in the German version of *Come Dine with Me* called *Das perfekte Dinner*, and contrast our theoretical results with this observed behaviour. We then provide possible explanations for the prevailing off-equilibrium behaviour.

[9]More precisely, that part of *Come Dine with Me* where players evaluate each other's dinner party may be interpreted as a non cooperative game between the participants where their strategic variables are the evaluations. We focus on these evaluation strategies and abstract from all other possible issues.

In the German format, no player (contestant) has ever played a zero evaluation vector in either of the 212 rounds played between 2006 and 2011, and accordingly the *zero equilibrium* has never been realised.[10] This is a remarkable observation as the *zero equilibrium* is a Nash equilibrium in weakly dominant strategies, *i. e.* the zero-evaluation vector constitutes a weakly best-reply for each player irrespective of the strategies chosen by the other players. In this sense, the choice of the zero-evaluation vector represents an apparently attractive strategy as it is (weakly) beneficial for any player, and it also yields the potentially largest payoff gain among all available evaluation strategies for any given strategy profile of the other players. For this reason, the *zero equilibrium* may veritably be regarded as a focal point in the sense of Schelling (1960),[11] although numberless other (weak) Nash equilibria exist.

Remarkably, not also has the *zero equilibrium* never been played in 212 rounds of *Das perfekte Dinner*, but also did non-zero equilibria not emerge repeatedly: In fact, only in one round has a non-zero equilibrium been played. This implies that in 211 rounds a contestant not receiving some prize money could have attained a larger prize by evaluating his contenders at lower scores. The presence of the potential for profitable deviation were so ubiquitous that even winners could increase their payoff in 33 rounds where the win was split among two (29 cases), three (3 cases) and four players (1 case). The possibilities for profitable deviation were not only omnipresent, but also so significant that even the very last ranked contestant could have attained an exclusive win in 43.88% and a shared win in 12.26% of the cases; and only in two cases deviating (by losers) had maximally brought about a split win only. In sum, off-equilibrium behaviour is clearly the rule rather than an exception in the German version of *Come Dine with Me*; and the focal point, the *zero equilibrium*, has never been played — and is thus apparently out of the players' focus.

The most immediate explanation for this off-equilibrium behaviour is that with 11 evaluation levels (namely with levels $0, 1, ..., 10$) and five players the set of possible strategy profiles consists of $11^{20} \approx 672.75 \times 10^{18}$ different evaluation matrices, and accordingly the set of (weak) Nash equilibria is extraordinary large. Since during the show a contestant does not know the evaluations made (strategies chosen) by other contestants, and the number of non-zero equilibria is huge, there is virtually no chance for participants to coordinate on any of these (weak) equilibria. Consequently, a realisation of any of these non-zero equilibria may be attributed to accident rather than to intention or coordination — and, in fact, this happened only once.

[10]The statistics we use are available in disaggregated form from the homepage of "Das perfekte Dinner" of the German TV-channel VOX broadcasting: http://www.vox.de/kochen/das-perfekte-dinner/details.

[11]Cooper et al. (1990) and Mailath (1998) provide evidence that Nash equilibria often are focal points in non-cooperative games.

Yet, since the *zero equilibrium* represents, as argued above, a focal point, we might expect participants to focus on this equilibrium. As this does not come about, there must be other factors which prevent participants from playing the *zero equilibrium*. The literature may provide several potential explanations for this behaviour, which we will now discuss: The impact of social pressure and reputation mechanisms, bandwagon effects, inequality aversion and sequential voting effects.

Concerning social pressure and reputation effects, a starting point is to realise that the *Come Dine with Me* show has some common features with joy-of-destruction games.[12] In these games, a player has the opportunity to reduce another player's wealth at some small cost without standing to gain anything except for the potential joy of destruction. One can consider the *Come Dine with Me* show as a variant of such a setting: Starting from a fair evaluation as the reference point, which regularly requires strictly positive evaluations, a contestant may choose to reduce his evaluation of the dinner of some or all other participants just for the joy of destruction (which may have its root in malevolence or enviousness). Clearly, a contestant may benefit from an under-evaluation of the performance of his co-contestants, but in those cases where a player does not obtain a higher payoff by decreasing another contestant's evaluation, *Come Dine with Me* features similarity with a joy-of-destruction game.

Moreover, a strategy of under-evaluation, and in particular the zero strategy, can be played in anonymity during the show, so that a destructive strategy remains undisclosed *in mediis*. Abbink and Sadrieh (2009) and Abbink and Herrmann (2011) conduct joy-of-destruction experiments, where there is a chance that burning money remains hidden. They find that money burning rates increase significantly when there is a degree of anonymity involved. However, in the *Come Dine with Me* show disaggregated voting behaviour will be made public to both the other contestants and millions of viewers about three months after the contest when the show is eventually broadcast. Thus, there is a delayed publicity effect. In his seminal article Bernheim (1994, p. 844) concludes: "When popularity is sufficiently important relative to intrinsic utility (defined as utility directly derived from consumption), many individuals conform to a single, homogeneous standard of behaviour, despite heterogeneous underlying preferences". Therefore, one potential explanation for the off-equilibrium behaviour in the actual show is that publicity keeps people from playing the zero strategy. In this vein, Holländer (1990) and Benabou and Tirole (2006) provide further evidence that such an effect might play an important role.

Beyond publicity effects, people may condition their present behaviour on previously observed behaviour — and in this sense, bandwagon effects may arise. Aardema et al. (1977) show that contestants condition their evaluations on evaluations given

[12] For a general description of joy of destruction games and some experimental results see for example, Zizzo and Oswald (2001); Zizzo (2003).

in previous shows. Consequently, if contestants observe relatively high evaluations in shows already broadcast, this may affect their present voting behaviour as they do not want to endanger their reputation by deviating from an established social norm. Similarly, Young (1996) finds that stable focal points, such as, for example, a 50:50 division in a bargaining game, often evolve over time until they become focal eventually. In this way, a social standard may be established in initial shows requiring contestants to refrain from playing the zero strategy. If this implicit rule is accepted — again implicitly — by subsequent contestants, this might explain why we never observe the *zero equilibrium*.

Furthermore, inequality aversion of contestants might be relevant. Fehr and Schmidt (1999) introduce a utility function based on inequality aversion to explain the behaviour in different experiments. They argue that people are averse of outcomes that are distant from a previously established social standard, in particular with respect to negative deviations. For the setting of *Come Dine with Me* this implies that contestants are more willing to give evaluations which are too positive rather than too negative, relative to a social standard calling for fair evaluations. The average evaluation in the German version of the show between 2006-2011 is 7.57 points, and we rarely observe any evaluations below 4. Moreover, a positive bias attributable to inequality aversion may provide a possible explanation for this generous evaluation behaviour. Both reasons may contribute to explaining why contestants rarely play strategies with low evaluations which might actually improve their chances of winning considerably.

Finally, the sequential effect already recognized by Haigner et al. (2010) for *Das perfekte Dinner* and by Page and Page (2010) for the Idol series[13] may provide another explanation for off-equilibrium behaviour. Both articles find that contestants performing later in the respective show receive higher evaluations. One explanation for this effect is that later contestants adapt to previous performances via so-called direction-of-comparison effects: "It appears that judges form an impression of each new option by comparing it to those that preceded it. Using that option's features as a 'checklist,' more weight is given to unique ones than to ones shared with previous options. This unidirectional comparison process produces increasing ratings in options with unique positive features, and decreasing ratings when options have unique negative features." (see Bruine de Bruin and Keren, 2003, p. 91). Contestants cannot change their menu in the *Come Dine with Me* show once the contest has started, and the skill of a chef is unlikely to change significantly over the course of the contest week. Hence, the only way for a contestant to adapt his behaviour in response to the performance of his precursors is to invest more money and effort to enhance decoration, to engage an artist for a performance during the dinner etc. If

[13]The Idol series is broadcast in UK under the title "Pop Idol", in the US as "American Idol" and in Germany as "Deutschland sucht den Superstar".

these improvements are performed, contestants may induce an upward shift in the perceived socially acceptable evaluation — and sequential effects of this type can help to explain why we do not observe low evaluations.

5. Conclusion

In this paper we looked at the TV-Show *Come Dine with Me* from a strategic perspective. To this end, we interpreted and modelled this show as a simultaneous non-cooperative game with purely self-regarding preferences of the players (*viz.* contestants) and mutual evaluation levels as their strategic variables. We showed that *Come Dine with Me* belongs to a class of games to which we refer as *mutual evaluation games (MEG)*. Each MEG possesses multiple Nash equilibria, each of which is characterised by two conditions: (1) Each winner assigns a zero score (lowest possible score) to all other co-winners, if there are any; (2) For each loser there is at least one other player (who may be a loser or a winner) such that even if this loser were to evaluate all other players with a zero score, there is still (at least) one contestant who has a higher total score. Thus, in equilibrium, any winner cannot reduce the number of co-winners (condition 1); while any loser may affect the set of winners, but cannot accomplish to become a member of the group of winners (condition 2).

We showed that in a game with three contestants (players) and two evaluation levels has four Nash equilibria. Adding one additional evaluation level, we find that the resulting three-player game with three evaluation levels possesses 55 equilibria — and this number quickly soars as the number of players or evaluation levels increases. Also, irrespective of the number of players and the number of evaluation levels, any MEG possesses a unique Nash equilibrium in weakly dominant strategies: the *zero equilibrium* in which all players evaluate each other with zero scores. As long as we disregard (potential) social preferences and fairness considerations and, thus, focus on the monetary gains exclusively, this *zero equilibrium* should represent a focal point of the game.

We contrasted our theoretical results with actual behaviour in the German version of the show. The *zero equilibrium* has never been played in any show during 2006-2011. In fact, only in four cases did a contestant evaluate another contestant with a zero score. Furthermore, off-equilibrium behaviour is significantly more often observed than equilibrium behaviour, which happens to emerge only once within 212 rounds. Considering that the number of equilibria in a 5 player/11 evaluations space is remarkably large, one explanation for this observed off-equilibrium behaviour is that contestants simply cannot coordinate on any equilibrium. However, contrasting the average evaluation of 7.57 with the *zero equilibrium* as the focal point, it becomes clear that there must be other factors than payoff concerns, that bring about this differential.

We provided four different potential explanations for this phenomenon: The impact of social pressure and reputation mechanisms, bandwagon effects, inequality aversion and sequential voting effects. We showed that all effects can help to explain off-equilibrium behaviour and the seemingly positive evaluation bias. In sum, the goal of this paper was to provide a game theoretical background for this type of mutual evaluation games, and to provide potential explanations for actual behaviour compared to the game-theoretical predictions. Future research on this topic should focus on empirically measuring the impact of factors that may help to explain actual behaviour in a mutual evaluation game such as *Come Dine with Me*.

References

Bobette Aardema, David Myers, and Sandra Wojcicki. Attitude Comparison: Is There Ever a Bandwagon Effect? *Journal of Applied Psychology*, 7(4):341–347, 1977.

Klaus Abbink and Benedikt Herrmann. The Moral Costs of Nastiness. *Economic Inquiry*, 49(2):631–633, 2011.

Klaus Abbink and Abdolkarim Sadrieh. The pleasure of being nasty. *Economics Letters*, 105(3):306–308, 2009.

Ali M. Ahmed. Women Are Not Always Less Competitive Than Men: Evidence from Come Dine with Me. *Applied Economics Letters*, 18(10-12):1099–1101, 2011.

Shamena Anwar. Testing for Discrimination: Evidence from the Game Show Street Smarts. *Journal of Economic Behavior and Organization*, 81(1):268–285, 2012.

Roland Benabou and Jean Tirole. Incentives and Prosocial Behavior. *American Economic Review*, 96(5):1652–1678, 2006.

Randall W. Bennett and Kent A. Hickman. Rationality and the Price is Right. *Journal of Economic Behavior and Organization*, 21(1):99–105, 1993.

Jonathan B. Berk, Eric Hughson, and Kirk Vandezande. The Price Is Right, but Are the Bids? An Investigation of Rational Decision Theory. *American Economic Review*, 86(4):954–970, 1996.

Douglas Bernheim. A Theory Of Conformity. *Journal of Political Economy*, 102(5): 841–877, 1994.

Wändi Bruine de Bruin and Gideon Keren. Order Effects in Sequentially Judged Options due to the Direction of Comparison. *Organizational Behavior and Human Decision Processes*, 92(1-2):91–101, 2003.

Russell W. Cooper, Douglas V. Dejong, Robert Forsythe, and Thomas W. Ross. Selection Criteria in Coordination Games: Some Experimental Results. *American Economic Review*, 80(1):218–233, 1990.

Luis C. Corchon. Comparative Statics for Aggregative Games: The Strong Concavity Case. *Mathematical Social Sciences*, 28(3):151–165, 1994.

Ernst Fehr and Klaus M. Schmidt. A Theory of Fairness, Competition, and Cooperation. *The Quarterly Journal of Economics*, 114(3):817–868, 1999.

Stefan D. Haigner, Stefan Jenewein, Florian Wakolbinger, and Hans-Christian Müller. The First Shall Be Last: Serial Position Effects in the Case Contestants Evaluate Each Other. *Economics Bulletin*, 30(4):3170–3176, 2010.

Heinz Holländer. A Social Exchange Approach to Voluntary Cooperation. *American Economic Review*, 80(5):1157–1167, 1990.

Martin Kaae Jensen. Aggregative Games and Best-Reply Potentials. *Economic Theory*, 43(1):45–66, 2010.

George J. Mailath. Do People Play Nash Equilibrium? Lessons From Evolutionary Game Theory. *Journal of Economic Literature*, 36(3):1347–1374, 1998.

Lionel Page and Katie Page. Last Shall Be First: A Field Study of Biases in Sequential Performance Evaluation on the Idol Series. *Journal of Economic Behavior and Organization*, 73(2):186–198, 2010.

Thomas Schelling. *The Strategy Of Conflict*. Harvard University Press, Cambridge, MA, 1960.

Martijn J. van den Assem, Dennie van Dolder, and Richard H. Thaler. Split or Steal? Cooperative Behavior When the Stakes Are Large. *Management Science*, 58(1): 2–20, 2011.

H. Peyton Young. The Economics of Convention. *Journal of Economics Perspectives*, 10(2):105–122, 1996.

Daniel Zizzo and Andrew J. Oswald. Are People Willing to Pay to Reduce Others' Incomes? *Annales d'Economie et de Statistique / Annals of Economics and Statistics*, 63-64:39–65, 2001.

Daniel John Zizzo. Money Burning and Rank Egalitarianism with Random Dictators. *Economics Letters*, 81(2):263–266, 2003.