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Quantum dynamical modeling of competition and cooperation between political parties: The coalition and non-coalition equilibrium model

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HIGHLIGHTS

- The formalism of quantum physics is used to devise a dynamical model of party coalition formation.
- Quantum entanglement is introduced to account for the close interrelation of parties' decisions.
- Numerical simulations and graphical representations of results are presented.

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ABSTRACT

We propose a model of parties' dynamical decision-making related to becoming a member of a coalition or pursuing a competitive strategy. Our approach is based on the mathematical formalism of quantum information theory. The devised model has no direct relation to quantum physics, only its mathematical apparatus and methodology are applied, in particular the quantum probability and the theory of open quantum systems. The latter describes the most general form of adaptive dynamics of a system interacting with an environment. In our model the environment is composed of the electorate, or more specifically the informational bath generated by the parties' electorate, which is a key part of the socio-economic context surrounding the political party as a decision-making entity. The key feature of the quantum model is the ability to capture the strong interrelation of the parties' decision making states, through the notion of entanglement. The preferences of different parties evolve simultaneously and non-separably in the joint information space. We model the approaching of the state of political equilibrium by using the Markov approximation of the quantum master equation. Illustrative examples of numerical simulations are presented to specify, how the model works operationally.

1. Introduction

Mathematical modeling of creation of coalitions between political parties and, more generally, of establishing cooperation with respect to the special political and economic issues is by now a well researched field. Generally speaking, the choices of political parties depend on a number of psychological and institutional parameters. Different models consider different parameters as being more salient to the parties' decisions. If one would search to construct a classical stochastic model with multiple loading factors that would also change over the time dynamics, one would obtain an extremely complex model. In this contribution, we propose a model that is based on the formalism of quantum information theory (quantum Markovian dynamics). The advantage of the devised model is that it reduces essentially the complexity of the classical stochastic models. The model can be potentially adapted to a variety of political issues, where the parties are uncertain in respect to cooperation/non-cooperation with other parties on some political matters. However, as was pinpointed by one of the reviewers of this paper, the topic of (non)cooperation would require a more scrutinized analysis, where the party can often cooperate only to a certain degree, involving several issues on which the party has to decide. In the case of a coalition formation the party has formally only two choices in the form of yes/no. In this piece of work we are proceeding on a formal level, by presenting a model that describes an equilibrium state of the parties that operate in a country with multiparty political system. The core decisions that these parties have to make are simplified to the set of two choices "*to enter*

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a political coalition (alliance) or to abstain from entering a coalition (alliance)".[1]

In this paper we do not have a possibility to review in detail the "classical methods" for the investigation of the domain of cooperation and competition, including the context of coalition formation in politics, see, e.g., monographs by Davis, Hinich, and Ordeshook (1970) and Dhillon (2005) for extended treatments. For our purpose, it is important to point out that one of the main aims of "classical mathematical modeling" is to study the overall existence and the process of approaching to the states of an *equilibrium* of preferences for (non)cooperation between parties.[2]

Certainly, game theory plays a crucial role in this setting, since coalition formation is a strategic process that embraces a complexity of factors for each partaking party. Each party has to consider the preferences and aims of the other parties, in order to establish its best strategy and ultimately achieve an optimal equilibrium for all political players involved. For a treatment from a game theoretic perspective on the coalition formation, consult Greenberg (1994) and Riker (1962). In his landmark work on political coalitions Riker (1962) puts forward a well-known theory on political bargaining, stating that the main aim of each separate party is not to win the support of the largest amount of voters, but to form a "minimal winning coalition". According to the theory, such type of party's behavior enables it to save its energy and resources that would be spent in an extensive election campaign. In contrary, more recent works by Brams and Fishburn (1992) and Greenberg (1994) show evidence on the electorate playing a central role in the formation of party's cooperative/non-cooperative strategy. In the later study, Brams and Fishburn (1992) articulate that voters are active complements in terms of shaping the strategy of the parties in multi-party political systems. In this respect, the ultimate aim for the political parties is to form such coalitions that would satisfy the voters, by bringing a convergence of their political interests and ideology. For instance, Meffert and Geschwend (2010) carried out a study on voters in Austria and found out that the voting behavior of Austrian electorate displays "non-separability". The collected statistics showed that Austrian voters are considering all the election outcomes simultaneously, including the potential coalition possibilities of the parties. The complex mode of voters' information processing can establish voting preferences for some political party, given that it will become a member of a particular coalition. The victory of the political parties depends on the "message" that the existing coalition or the potential coalition members convey to the electorate.[3] The parties that solely focus on the preferences of voters, the so called "vote maximizers", are highly dependent on the voting behavior of the electorate, see the seminal work by Downs (1957). At the same time, a political party may place more value on sustaining its ideology, the so called policy seeking behavior. The third factor that may determine the strategy of the party is its aspiration for power, fulfilled by the means of increasing the number of its cabinet seats. Strom (1990) explored the above factors' impact on parties' behavior, and formalized a "three factor" theory of coalition formation. Despite the orthogonal representation of the three key factors; policy seeking, cabinet seats seeking and voter support seeking in this spatial model, the author acknowledges that these factors are often not mutually exclusive but interconnected i.e., they are non-separably coupled in the process of party's decision making. Naturally, the ideology of the party is reflecting the aspirations of the voters as well as its desire for cabinet sits. Consequently, it becomes not possible for a party to fulfill its goals without the voters support, in a multi-party democracy. Moreover, the support of voters is vital for the very existence of the party on the political arena, where the most multi-party political systems have a requirement of passing an election threshold.

We also remark the importance of the timing of the coalition formation, as often discussed in political literature. A pre-election alliance emerges, when the parties participate in the elections process as a joint "team". Similarly, after the elections, the power distribution cannot be altered by other means than by creating a coalition with other parties, in order to form a minority/majority government. Notable cases of alliances[4] that emerged before the elections were held are the "Alliance" in Sweden and "Syriza" in Greece (Syriza Party Homepage, 2013; Widfeldt, 2007). The type of alliance-seeking behavior can be characterized by the parties' need to gain the support of voters as a result of the created image by the alliance members. Conventionally, in the process of alliance formation, the involved parties search to keep close their ideological ties on the so called left–right policy axis. In such contexts, the parties are dependent on the beliefs of voters about their success as an alliance. As a consequence, the parties search to be perceived by the voters as a strong and reliable political entity, see a discussion in The Electoral Knowledge Network (2012). The impact of voters is even more imperative for the post-election coalition emergence. In some cases the parties are left with no other options, but to establish a coalition agreement to stay in power. Many alliances and coalitions, such as the "Grand Coalitions" in Germany, Italy and the Netherlands, as well as the coalition in the UK, were created in order to secure cabinet sits for the party members. This strategy enabled the parties to form a Government with majority sits, see mass-media coverage in BBC News (2010), BBC News (2013), Financial Times (2012) and Spiegel Online International (2013).

The coalition formation is a complex process and an optimal equilibrium has to be established for the whole arrangement of participants. The voters definitely have a great impact on the strategic planing of their representative political parties. The voters are effectively shaping the strategy of these parties through their voting behavior on the election day. However, the parties that enter a coalition also keep in mind that the voters' support can swing in favor of an another political party, if their interests become neglected. The party's success in the subsequent elections can be easily jeopardized.

As Downs (1957, p. 35), formulated in his milestone work: …*"the main goal of every party is the winning of elections. Thus, all its actions are aimed at maximizing votes"*.

In the proposed model, the timing of the coalition formation can be tuned with the aid of appropriate Hamiltonian and Lindblad operators that incorporate the internal and external state

[1] In the spirit of information theory we encode each single party's decision state by the so called quantum bits. Each quantum bit is encoding a probabilistic superposition of obtaining some binary (customarily denoted in quantum information theory as zeros or ones) outcomes. This allows us to represent decision states with the choice outcomes in the form of "yes" and "no" with the aid of qubits. This approach, as will be shown, simplifies the model construction essentially.

[2] We highlight that in this work we operate with the words "cooperation" and "non-cooperation", as conceived in the classical game theory. In the proposed model these terms more precisely denote the acts of "entering a coalition/alliance" or "not entering a coalition/alliance".

[3] An interesting example of the complex interplay of voters' expectations and the strategies of the political parties is the success of an intricate multi-party coalition, termed "Alliance". This coalition came to power in Sweden in the 2006 parliamentary elections after 4 center-right parties merged together to oppose the leading party, the Social Democrats. The process of coalition formation was accompanied by various disagreements. Finally, the "Alliance" was able to formulate a joint political program, the so called "Manifesto". The success of this multi-party coalition was attributed to the transparency of the conveyed information about their coalition plans and the subsequent supportive voting behavior of the Swedish electorate. For detailed statistics consult the study by Widfeldt (2007).

[4] Pre-election coalitions are often termed alliances.