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3-Player 3-Strategy Nash Equilibrium of Party's Presidential Primaries in the Build-Up to 2023 General Elections in Nigeria

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ABSTRACT

The research formulated a political game model of All Progressive Congress (APC) Party Contestants for the Presidential Primaries in order to determine the best possible candidate who would be presented by the Party for winning the 2023 General Election in Nigeria. The method of solution involved Nash equilibrium which yielded a pure Nash result of Propaganda, Consultation and Youth mobilization Strategies for Yahaya Bello, Ahmed Bola Tinubu and Yemi Osinbajo respectively. The study concluded that, the outcome of the Party's primaries which produced Ahmed Bola Tinubu as its flag bearer was consistent with the model's result. Because, Ahmed Bola Tinubu did a lot of deep consultation with stakeholders while Yahaya Bello's best response was propaganda as Osibanjo was preferred by the Youth of the Party.

1. Introduction

In a presidential election, selecting the optimal candidate from a pool of three contenders presents a complex decision-making challenge that can be effectively analyzed using operations research techniques. This article explores the application of 3-player 3-strategy Nash equilibrium method to address the problem of choosing the most suitable candidate based on various criteria, aiming to enhance the decision-making process in the electoral context (Nyor *et al.*, 200). Nash equilibrium, a fundamental concept in game theory, occurs when players in a strategic game choose strategies that are optimal given the strategies of all other players, resulting in no player having an incentive to unilaterally deviate (Nash, 1950). This equilibrium is named after John Nash, who proved that every finite game has at least one equilibrium point. In this state, each player's strategy maximizes their payoff, assuming the strategies of the others remain constant. Nash equilibrium applies to various fields, including economics, biology, and political science, illustrating how rational agents interact in competitive environments (Osborne and Rubinstein, 1994). For instance, in economics, firms in an oligopoly market may reach a Nash equilibrium where each firm's pricing strategy optimally responds to competitors, resulting in stable market prices (Tirole, 1988). The concept is pivotal in understanding strategic behavior and predicting outcomes in complex interactive scenarios.

Three contenders were taken into account in this model. These three candidates were the front-runners in the All Progressive Congress (APC) early permutation that took place in February 2022. The then Vice President Yemi Osinbajo, Governor of Kogi State at that time Yahaya Bello, and Ahmed Bola Tinubu.

Three presumptive strategies, representing potential campaign approaches for each of the three candidates, were taken into account for the APC Presidential Model: (i) Propaganda Political (P): This entails promoting one's candidacy via a variety of media outlets, including billboards, posters, pamphlets, and social media. This aids in spreading the candidates' message to a wide audience and improving their reputation. (ii) Consultation with Stakeholders (C): It is imperative to have consultations with influential party figures, including leaders, members, and supporters. This makes it easier to comprehend their viewpoints and worries, which the campaign can address. (iii) Youth Mobilization (Y): Young people make up a large share of the population and are essential to the election process. Therefore, the candidates ought to concentrate on energizing the youth by participation in events like town hall

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meetings, debates, and other youth-oriented gatherings. The candidates can raise their profile, get support, and ultimately win the primary by putting these strategies into practice.

Ensuring equitable competition and equal participation opportunities for all political parties is a critical function of the political system. It is crucial to think about actions that can be made to make the political system more competitive and to deter the employment of immoral strategies. The purpose of this model was to ascertain the optimal plan of action that Ahmed Bola Tinubu (A), Yahaya Bello (B), or Yemi Osinbajo (O) could employ in order to become the Party's nominee for president in the 2023 election (Ayo *et al.*, 2012; Nyor *et al.*, 2019; Nyor *et al.*, 2023; Wright *et al.*, 2017).

2. Related Works

The 3-player 3-strategy Nash equilibrium extends classical game theory by incorporating more complex interactions among three players, each with three possible strategies. This equilibrium concept demonstrates how players can reach a stable outcome where no one has an incentive to deviate unilaterally. Recent advancements in computational techniques have significantly improved our ability to find such equilibria in complex scenarios. For instance, Alizadeh *et al.* (2021) developed novel algorithms that enhance the efficiency of finding Nash equilibria in multi-player games, showing promise in addressing the challenges posed by these more intricate settings (Alizadeh *et al.*, 2021). In addition to computational advancements, theoretical insights into 3-player 3-strategy Nash equilibria have also progressed. Researchers have explored new theoretical frameworks and refinements that offer deeper understanding and broader applicability of Nash equilibrium concepts. Notably, Chen and Lin (2022) provided an extended theoretical analysis of equilibrium solutions in multi-player games, including detailed discussions on the stability and uniqueness of equilibria in such settings (Chen and Lin, 2022). Their work contributes to the theoretical foundation by examining how equilibria in 3-player games can be characterized and differentiated from simpler cases. Empirical applications of the 3-player 3-strategy Nash equilibrium have expanded into various domains, illustrating the practical relevance of these theoretical concepts. For example, studies have applied these models to competitive environments such as auction design and market competition. Liu *et al.* (2023) investigated the use of 3-player Nash equilibrium models in auction settings to better understand bidding strategies and outcomes (Liu *et al.*, 2023). Similarly, Zhang and Yang (2024) explored how these models can be used to analyze strategic behavior in networked systems, providing insights into real-world applications of Nash equilibria (Zhang and Yang, 2024).

3. Methodology

In contrast to a zero-sum game, where the gain of one player equals the loss of another, a Nash equilibrium occurs when each person chooses the best course of action in reaction to what the others have chosen. In order to achieve a three-player Nash equilibrium, Player 1 selects a column, Player 2 selects a row, and Player 3 selects the matrix. In this work, all pure strategy Nash equilibrium of the game is found using the underlining approach. Results-wise, the strategy is prioritized over the reward (Alós-Ferrer *et al.*, 2022). The following inquiries were included in a Google questionnaire that was created and distributed:

Q1. Which Person category most accurately characterizes you?

- a. Party Official
- b. Stake holder
- c. Youth Wing
- d. Women Wing
- e. Party Member

Q2. Taking into account the three strategies that the APC's three presidential candidates have at their disposal—political propaganda, stakeholder consultations, and youth mobilization—which of the three candidates do you firmly believe will be the party's nominee for president in 2023? Mark Just One candidate for a Plan.

(a) Based on political propaganda (P)

Ahmed Bola Tinubu, Gov. Yahaya Bello or the then Vice President Yemi Osinbajo

(b) Based on consultations with stakeholders (C)

Ahmed Bola Tinubu, Gov. Yahaya Bello or the then Vice President Yemi Osinbajo

(c) Based on youth mobilization (Y)

Ahmed Bola Tinubu, Gov. Yahaya Bello or the then Vice President Yemi Osinbajo

The purpose of this model is to predict how these tactics will affect the election's result and identify the candidate with the highest probability of winning in light of their chosen tactic. A matrix version of this game might be played, with the first player selecting the matrix, the second taking the row, and the third playing by column. Payoffs for the first player, second player, and third player are represented by the first, middle, and last values in each cell, respectively.

Let A, O and B be three players in a game with three available strategies P, C and Y for each player. And let p, c, y represent the payoff for strategies P, C and Y respectively, then the game diagram is as shown in Figure 1.

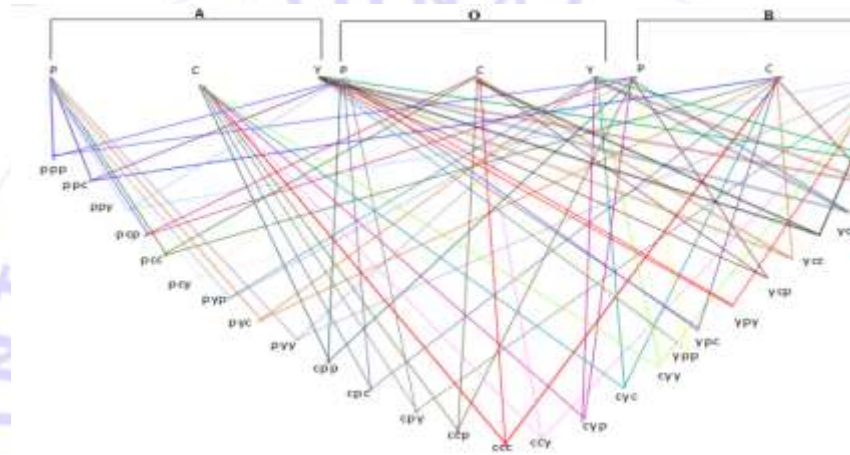


Figure 1: Flow Diagram of the Game Showing Players and Strategies.

The Game's Nash Equilibrium is computed in the following procedure:

Table 1: Payoff Description; Player 'A' adopts Political Propaganda (P)

O/B	P	C	Y
P	p;p;p	p;p;c	p;p;y
C	p;c;p	p;c;c	p;c;y
Y	p;y;p	p;y;c	p;y;y

Table 2: Payoff Description; Player ‘A’ adopts Consultation with Stakeholders (C)

O/B	P	C	Y
P	c;p;p	c;p;c	c;p;y
C	c;c;p	c;c;c	c;c;y
Y	c;y;p	c;y;c	c;y;y

Table 3: Payoff Description; Player A adopts Youth Mobilization (Y)

O/B	P	C	Y
P	y;p;p	y;p;c	y;p;y
C	y;c;p	y;c;c	y;c;y
Y	y;y;p	y;y;c	y;y;y

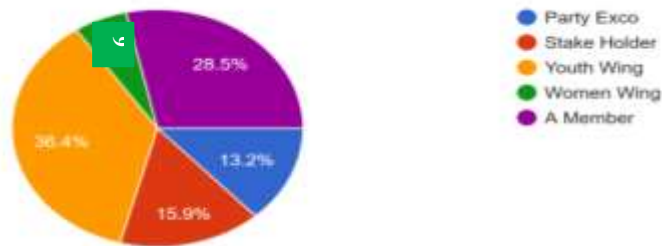


Figure 2: Percentages of categories of respondents to the survey



Figure 3: Data on Political Propaganda

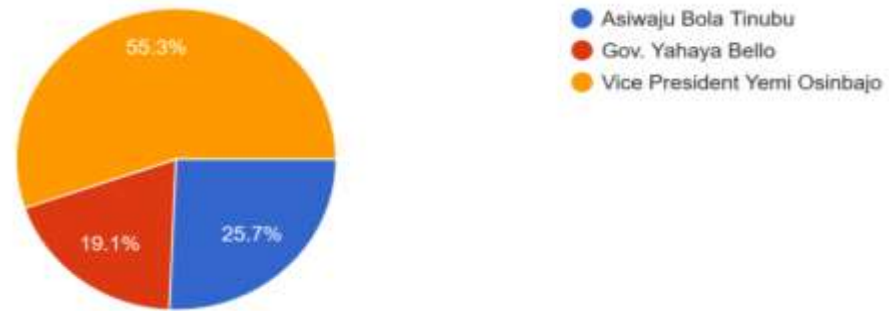


Figure 4: Data on Consultation with stake holders

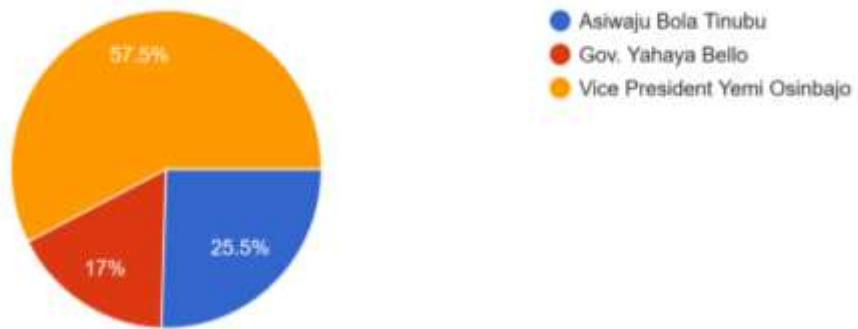


Figure 5: Data on Youth mobilization

For player A's best responses, we underline the highest value first entry in each column.

Table 4: Column Playing

		3rd PLAYER B PLAYS STRATEGY P			3rd PLAYER B PLAYS STRATEGY C			3rd PLAYER B PLAYS STRATEGY Y		
		2nd Player O			2nd Player O			2nd Player O		
		P	C	Y	P	C	Y	P	C	Y
1st Player A	P	<u>37.9</u> ; 44.4; <u>17.6</u>	37.9; 44.4 ;19.1	37.9; 44.4; 17	25.7; 44.4; 17.6	25.7; 44.4; 19.1	25.7; 44.4; 17	25.5; 44.4; 17.6	25.5; 44.4; 19.1	25.5; 44.4; 17
	C	<u>37.9</u> ; 55.3; 17.6	37.9; 55.3; 19.1	37.9; 55.3; 17	25.7; 55.3; 17.6	25.7; 55.3; 19.1	25.7; 55.3; 17	25.5; 55.3; 17.6	25.5; 55.3; 19.1	25.5; 55.3; 17
	Y	<u>37.9</u> ; 57.5; 17.6	37.9; 57.5; 19.1	37.9; 57.5; 17	<u>25.7</u> ; 57.5 ; 17.6	<u>25.7</u> ; 57.5 ; 19.1	<u>25.7</u> ; 57.5 ; 17	<u>25.5</u> ; 57.5; 17.6	<u>25.5</u> ; 57.5; 19.1	<u>25.5</u> ; 57.5; 17

Table 4 compares first entries of all the columns in the 3 matrices and underline the highest value. From Table 4, all the first entries have the same value of 37.9, consider the strategy whose next value is highest. In this case, select the 37.9 that is next to 57.5 as the highest next value

Table 5: Row Playing

		3rd PLAYER B PLAYS STRATEGY P			3rd PLAYER B PLAYS STRATEGY C			3rd PLAYER B PLAYS STRATEGY Y		
		2nd Player O			2nd Player O			2nd Player O		
		P	C	Y	P	C	Y	P	C	Y
1st Player A	P	<u>37.9</u> ; 44.4; 17.6	37.9; <u>44.4</u> ;19.1	37.9; 44.4; 17	25.7; 44.4; 17.6	25.7; <u>44.4</u> ; 19.1	25.7; 44.4; 17	25.5; 44.4; 17.6	25.5; <u>44.4</u> ; 19.1	25.5; 44.4; 17
	C	<u>37.9</u> ; 55.3; 17.6	37.9; <u>55.3</u> ; 19.1	37.9; 55.3; 17	25.7; 55.3; 17.6	25.7; <u>55.3</u> ; 19.1	25.7; 55.3; 17	25.5; 55.3; 17.6	25.5; <u>55.3</u> ; 19.1	25.5; 55.3; 17
	Y	<u>37.9</u> ; 57.5; 17.6	37.9; <u>57.5</u> ; 19.1	37.9; 57.5; 17	<u>25.7</u> ; 57.5 ; 17.6	<u>25.7</u> ; 57.5 ; 19.1	<u>25.7</u> ; 57.5; 17	<u>25.5</u> ; 57.5; 17.6	<u>25.5</u> ; 57.5 ; 19.1	<u>25.5</u> ; 57.5; 17

Table 5 highlight the highest value by comparing the second elements of each row in the three matrices. Take note that Table 5 works on Table 4, not Table 5. Table 5 compares the second entries in row P and finds that all of them are 44.4; nevertheless, the entry under method C is highlighted because it is higher than the next highest entry in P (17.6) and the one in Y (17). That is the method used in each of the three matrices' rows.

To highlight the greatest value, compare the third entries of each cell in the first matrix with the corresponding third entries in the second and third matrices. Keep in mind that Table 6 works on Table 5, not Table 6. In Table 6, the Table 6: Matrix Playing

		3rd PLAYER B PLAYS STRATEGY P			3rd PLAYER B PLAYS STRATEGY C			3rd PLAYER B PLAYS STRATEGY Y		
		2nd Player O			2nd Player O			2nd Player O		
		P	C	Y	P	C	Y	P	C	Y
1st Player A	P	37.9; 44.4; <u>17.6</u>	37.9; <u>44.4</u> ; <u>19.1</u>	37.9; 44.4; <u>17</u>	25.7; 44.4; 17.6	25.7; <u>44.4</u> ; 19.1	25.7; 44.4; 17	25.5; 44.4; 17.6	25.5; <u>44.4</u> ; 19.1	25.5; 44.4; 17
	C	37.9; 55.3; <u>17.6</u>	37.9; 55.3; <u>19.1</u>	37.9; 55.3; <u>17</u>	25.7; 55.3; 17.6	25.7; <u>55.3</u> ; 19.1	25.7; 55.3; 17	25.5; 55.3; 17.6	25.5; <u>55.3</u> ; 19.1	25.5; 55.3; 17
	Y	<u>37.9</u> ; 57.5; <u>17.6</u>	<u>37.9</u> ; 57.5; <u>19.1</u>	<u>37.9</u> ; 57.5; <u>17</u>	<u>25.7</u> ; 57.5; 17.6	<u>25.7</u> ; 57.5; 19.1	<u>25.7</u> ; 57.5; 17	<u>25.5</u> ; 57.5; 17.6	<u>25.5</u> ; 57.5; 19.1	<u>25.5</u> ; 57.5; 17

first cell's third entry (37.9; 44.4; 17.6) is compared to the corresponding third entries of the first cells in matrix 2 (25.7; 44.4; 17.6) and matrix 3 (25.5; 44.4; 17.6). This highlights the value of 17.6 in matrix 1, as the cell's first entry is higher than 25.5 in Matrix 2 and 3, and the second entries are all the same (44.4).

4. Discussion of Results

A pure Nash Equilibrium is found in Table 6 for 37.5%, 57.5%, and 19.1% of the APC Party membership population. For players B (Bello), A (Asiwaju), and O (Osibajo), this translates to Strategies P, C, and Y, respectively. According to this model, Player O's best play strategy is Youth mobilization, Y, whereas Player B's best play is strategy Propaganda, P. Player A's best reaction is strategy Consultation, C. The model makes it evident that respondents thought Yemi Osinbajo was the favored or acceptable candidate of the APC's youth for the presidency in the general election of 2023. Ahmed Bola Tinubu emerged as the APC flag bearer through extensive consultation and agreement, exactly as the model predicted, with the goal of establishing a more representative, moral, and equitable political system in Nigeria that involves all stakeholders.

5. Conclusion

The results of this model were congruent with the outcome of the Party's primaries, which led to the selection of Ahmed Bola Tinubu as its nominee. Because Osibanjo was favored by the Party's youth, Yahaya Bello's best answer was propaganda, but Ahmed Bola Tinubu conducted extensive consultations with stakeholders. The result emphasizes how critical it is to promote increased public involvement and engagement in the democratic process. This can contribute to the creation of a more democratic and accountable political system by ensuring that decisions made in politics are more reflective of the needs and preferences of the populace. According to the report, political parties should communicate with interested parties to gain a deeper understanding of the wants and requirements of the people they are running to serve. This will make Nigeria's political system more moral, representative, and balanced. Additionally, studies can be done to find out how different campaign tactics affect the results of elections and to determine whether game theory can be used to help guide political strategy.

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