Behavioral Turnout Models

An Application of Agent-based Modeling in Political Science

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Outline

BDT (2003)

- A computational model by assuming that voters are adaptively rational — voters learn to vote or to stay home in a form of trial-and-error.
- Voters are reinforced to repeat an action (e.g., vote) in the future given a successful outcome today.
- The turnout rate is substantially higher than the predictions in rational choice models.

Fowler (2006)

- Fowler revises the BDT model by including habitual voting behavior.
- He finds his behavioral model is a better fit to the same data that BDT use.

BDT (2003) Model

1. There are N voters in the society, such that, $n_d + n_r = N$.
2. Each voter i can either vote (V) or abstain (A).
   - If a citizen chooses to vote, she votes for her own party.
3. The winning party in the election is the party with the most turnout.
   - if ties, it will be decided by a fair coin toss.

Costs and Benefits of Voting

1. All members of the winning party receive a fixed payoff b.
   - regardless of whether or not they voted.
2. The individuals who choose to vote pay a fixed cost c.
3. Given the uncertainty is included in the payoff function: $\theta_{it} \sim iid\,(0, \omega)$, there are four possible groups with the following payoffs:
   1. Winning abstainers: $\pi_{i,t} = b + \theta_{it}$
   2. Winning voters: $\pi_{i,t} = b - c + \theta_{it}$
   3. Losing abstainers: $\pi_{i,t} = 0 + \theta_{it}$
   4. Losing voters: $\pi_{i,t} = -c + \theta_{it}$

Propensity to Vote

1. Each citizen i in each period t has a *propensity* to vote:
   1. Probability of Vote for individual i at time t: $p_{i,t}(V) \in [0,1]$
   2. Probability of Abstention: $p_{i,t}(A) = 1 - p_{i,t}(V)$.
2. Each citizen i has an *aspiration* level $a_{i,t}$ that specifies the payoff she hopes to achieve.
3. Each citizen realizes an action $I \in \{V, A\}$, which determines the election winner and the resulting payoff π_{it} for each citizen.

Propensity to Vote - Bush Mosteller Rule

- BDT (2003) follows Bush and Mosteller (1955) that propensities are adjusted according to whether or not that outcome is deemed successful.
- In other words, people would increase their likelihood of taking the same action next time if the resulting payoffs is greater than or equal to aspirations ($\pi_{it} \geq a_{it}$), and vice versa.
- The Propensity Function can be written as:
  - If $\pi_{i,t} \geq a_{i,t}$, then $p_{i,t+1}(I) = p_{i,t}(I) + \alpha(1 - p_{i,t}(I))$
  - If $\pi_{i,t} < a_{i,t}$, then $p_{i,t+1}(I) = p_{i,t}(I) - \alpha p_{i,t}(I)$
  - where $I \in \{V, A\}$, and $\alpha =$ speed of learning.

Propensity to Vote - Bush Mosteller Rule

1. Propensity to Vote for $t+1$ if the individual voted (V) at t:
    - If $\pi_{it} \geq a_{i,t}$, then $p_{i,t+1}(V) = p_{i,t}(V) + \alpha\left(1 - p_{i,t}(V)\right)$
    - If $\pi_{i,t} < a_{i,t}$, then $p_{i,t+1}(V) = p_{i,t}(V) - \alpha p_{i,t}(V)$
2. Propensity to Vote for $t+1$ if the individual abstained (A) at t:
    - If $\pi_{i,t} \geq a_{i,t}$, then $p_{i,t+1}(A) = p_{i,t}(A) + \alpha\left(1 - p_{i,t}(A)\right) \Rightarrow$ $p_{i,t+1}(V) = p_{i,t}(V) - \alpha p_{i,t}(V)$
    - If $\pi_{i,t} < a_{i,t}$, then $p_{i,t+1}(A) = p_{i,t}(A) - \alpha p_{i,t}(A) \Rightarrow$ $p_{i,t+1}(V) = p_{i,t}(V) + \alpha p_{i,t}(V)$
    - where $\alpha \in (0,1]$ is speed of learning.
    - This determines the speed in which propensities change in response to reinforcement (vote) and inhibition (abstain).

Aspiration Updating Mechanism

1. BDT (2003) also assume that each citizen's aspiration is updated according to Cyert and March (1963):

$$a_{i,t+1} = \lambda a_{i,t} + (1-\lambda)\pi_{i,t},$$

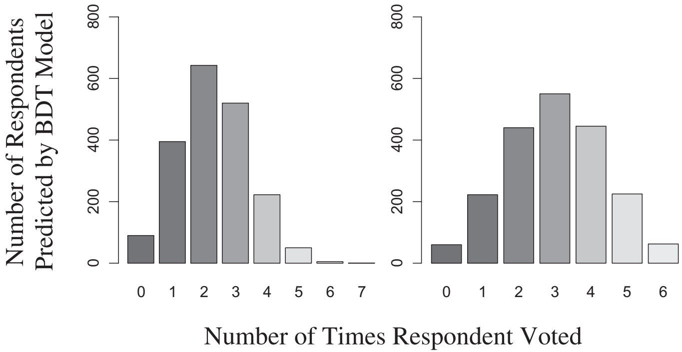
   where $\lambda \in (0,1)$
   1. If $\pi_{it} = a_{it}$, then $a_{i,t+1}$ does not change over time;
   2. If $\pi_{it} > a_{it}$, then $a_{i,t+1}$ increases;
   3. If $\pi_{it} < a_{it}$, then $a_{i,t+1}$ decreases.
2. Note that some individuals are inertial who do not update either propensity or aspiration or both randomly with probabilities of ε_p and ε_a, respectively.

BDT (2003) - Simulations

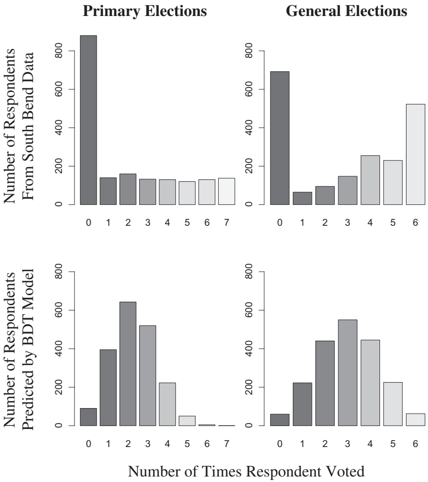
Parameter Values:

- $N = 10,000 \Rightarrow n_D = 5,000$ and $n_R = 5,000$
- $b = 1$ (benefit) and $c = .025$ (cost)
- $\alpha = 0.1$ (learning speed) and $\lambda = 0.95$ (aspiration adjustment)
- $\omega = 0.2$ (payoff noise), $\varepsilon_p = \varepsilon_a = 0.01$ (proportion of nonresponsive citizens)
- $p_{i,t=0} = a_{i,t=0} = 0.5$ (initial values)

BDT (2003) - Simulations



BDT (2003) vs Empirical Implications



BDT (2003) vs Empirical Implications

Recall the Propensity function:

- If $\pi_{i,t} \geq a_{i,t}$, then $p_{i,t+1}(I) = p_{i,t}(I) + \alpha(1 - p_{i,t}(I))$
  - When $p_{i,t}(I) = 0$, $p_{it+1}(I) \uparrow$ by α
  - When $p_{i,t}(I) = 1$, $p_{it+1}(I) = p_{it}(I)$. (no change)
  - As $p_{it}(I)$ increases, the reinforcement effect diminishes.
- If $\pi_{i,t} < a_{i,t}$, then $p_{i,t+1}(I) = p_{i,t}(I) - \alpha p_{i,t}(I)$
  - When $p_{i,t}(I) = 1$, $p_{it+1}(I) \downarrow$ by α
  - When $p_{i,t}(I) = 0$, $p_{it+1}(I) = p_{it}(I)$. (no change)
  - As $p_{it}(I)$ decreases, the inhibition effect diminishes.

BDT (2003) vs Empirical Implications

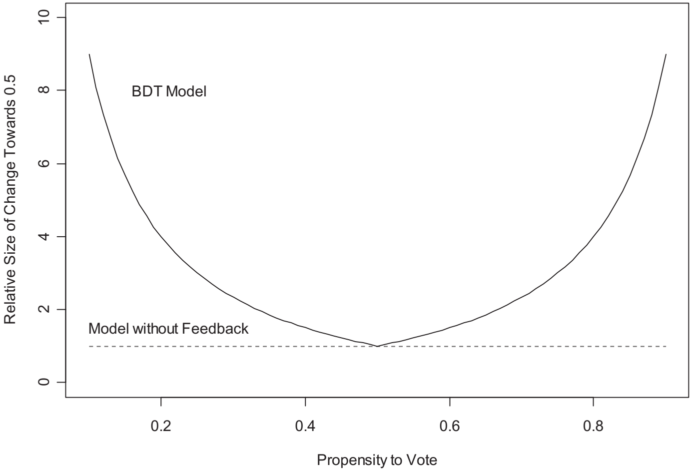
- The Propensity function:
  - If $\pi_{i,t} \geq a_{i,t}$, then $p_{i,t+1}(I) = p_{i,t}(I) + \alpha(1 - p_{i,t}(I))$
  - If $\pi_{i,t} < a_{i,t}$, then $p_{i,t+1}(I) = p_{i,t}(I) - \alpha p_{i,t}(I)$
- The expected propensity value is:

$$E(p_{i,t+1}) = Pr(\pi_{it} \geq a_{it})[p_{i,t}(I) + \alpha(1 - p_{i,t}(I))] + Pr(\pi_{it} < a_{it})[p_{i,t}(I) - \alpha p_{i,t}(I)]$$

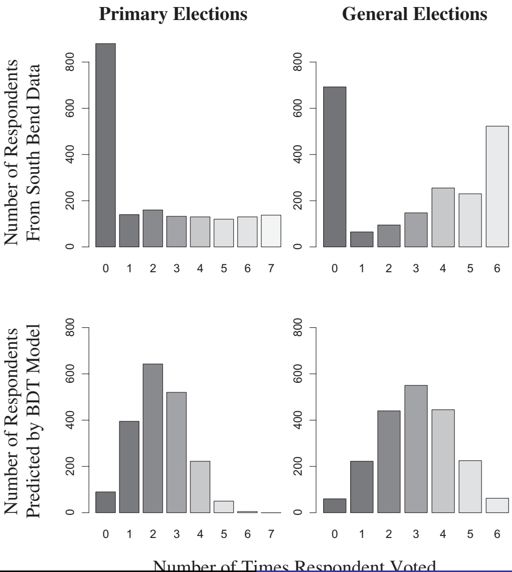
- Propensity to vote is $p_{i,t} = Pr(\pi_{it} \geq a_{it})$, and we assume the probability of success $Pr(\pi_{it} \geq a_{it}) = 0.5$, we have:

$$E(p_{i,t+1}) = p_{i,t} = 0.5.$$

BDT (2003) vs Empirical Implications



BDT (2003) vs Empirical Implications



Outline

1. Adaptively Rational Voting Model
    - Bendor, Diermeier and Ting (BDT) (APSR 2003)
    - Fowler (JOP 2006)

Fowler (2006) - Alternative Propensity Function

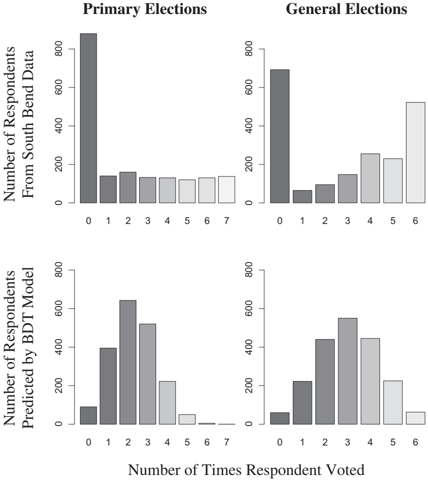
- Fowler (2006) revises the Propensity function:
  - If $\pi_{i,t} \geq a_{i,t}$, then $p_{i,t+1}(I) = \min(1, p_{i,t}(I) + \alpha)$
  - If $\pi_{i,t} < a_{i,t}$, then $p_{i,t+1}(I) = \max(0, p_{i,t}(I) - \alpha)$
  - At any level of $p_{i,t}$, the change of $p_{i,t}$ is either α for $\pi_{i,t} \geq a_{i,t}$ or $-\alpha$ for $\pi_{i,t} < a_{i,t}$, as long as $p_{i,t} \neq 0$ or 1.
  - Its change does not decrease as $p_{i,t}$ increases or decreases as suggested by BDT (2003).

Fowler (2006) - Alternative Propensity Function

- This implies that the reinforcement effect or the inhibition effect does not diminish as propensity of voting is increase or decreasing, respectively.
  - It does not converge to $E\left(p_{i,t+1}\right) = 0.5$ in the long run.
- As a result, many of them will have very high and very low propensities that cause them to make the same turnout choice for a long series of elections.
- This is called the habitual voting behavior.

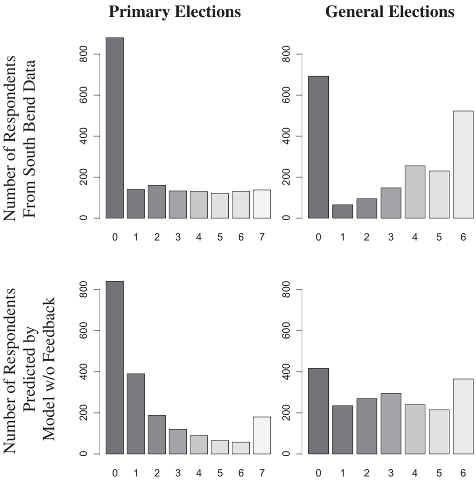
Fowler (2006) - Simulations

Recall: Simulations in BDT (2003)



Fowler (2006) - Simulations

Simulations in Fowler (2006)



Fowler (2006) - Simulations

Fowler (2006) Simulation created by Jeremy Gilmore

https://j-gilmore.shinyapps.io/fowlermodel/

Sources of Figures

Thank You!

Questions!