

**Ritam Pal**  
Department of Physics  
Indian Institute of Science Education and Research  
Pune 411008, India  
ritam.pal@students.iiserpune.ac.in

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Washington, DC 20001

Dear Editors,

We submit our manuscript “Voter Turnouts Govern Key Electoral Statistics” for consideration as a Brief Report in PNAS.

**Key Finding:** We demonstrate that voter turnout—typically treated as a mere indicator of public interest—encodes far richer information: it is sufficient to accurately predict the complete vote distributions of election winners and runners-up. This universal relationship holds across 12 countries spanning multiple decades and across all electoral scales, from large parliamentary constituencies ( $\sim 10^6$  voters) down to individual polling booths ( $\sim 10^2$  voters).

**Significance:** Our discovery offers a new quantitative lens for analyzing elections as complex systems. Using the Random Voting Model (RVM) with only two empirical inputs—turnout data and effective number of candidates—we reproduce the observed vote distributions without any country-specific assumptions. This finding is validated through three independent approaches: extensive empirical analysis, RVM simulations, and analytical derivations in the large-turnout limit. Critically, our results suggest a novel forensic tool: systematic deviations from the turnout-predicted distributions could signal electoral irregularities.

**Relationship to Prior Work:** This extends our recent Phys. Rev. Lett. work [R. Pal et al., **134**, 017401 (2025)] from victory margins to complete vote distributions, revealing turnout as a fundamental determinant of key electoral outcomes.

**Contributions:** All authors developed the conceptual framework. R.P. performed theoretical calculations, data analysis, and simulations. A.K. contributed theoretical insights. M.S.S. supervised the project. | **Conflicts:** None. | **Data:** Publicly available from official election commissions; code available upon publication.

We suggest categories: *Applied Physical Sciences* and *Social Sciences* (Political Sciences).

Sincerely,

**Ritam Pal**, on behalf of all authors