Data analysis of elections

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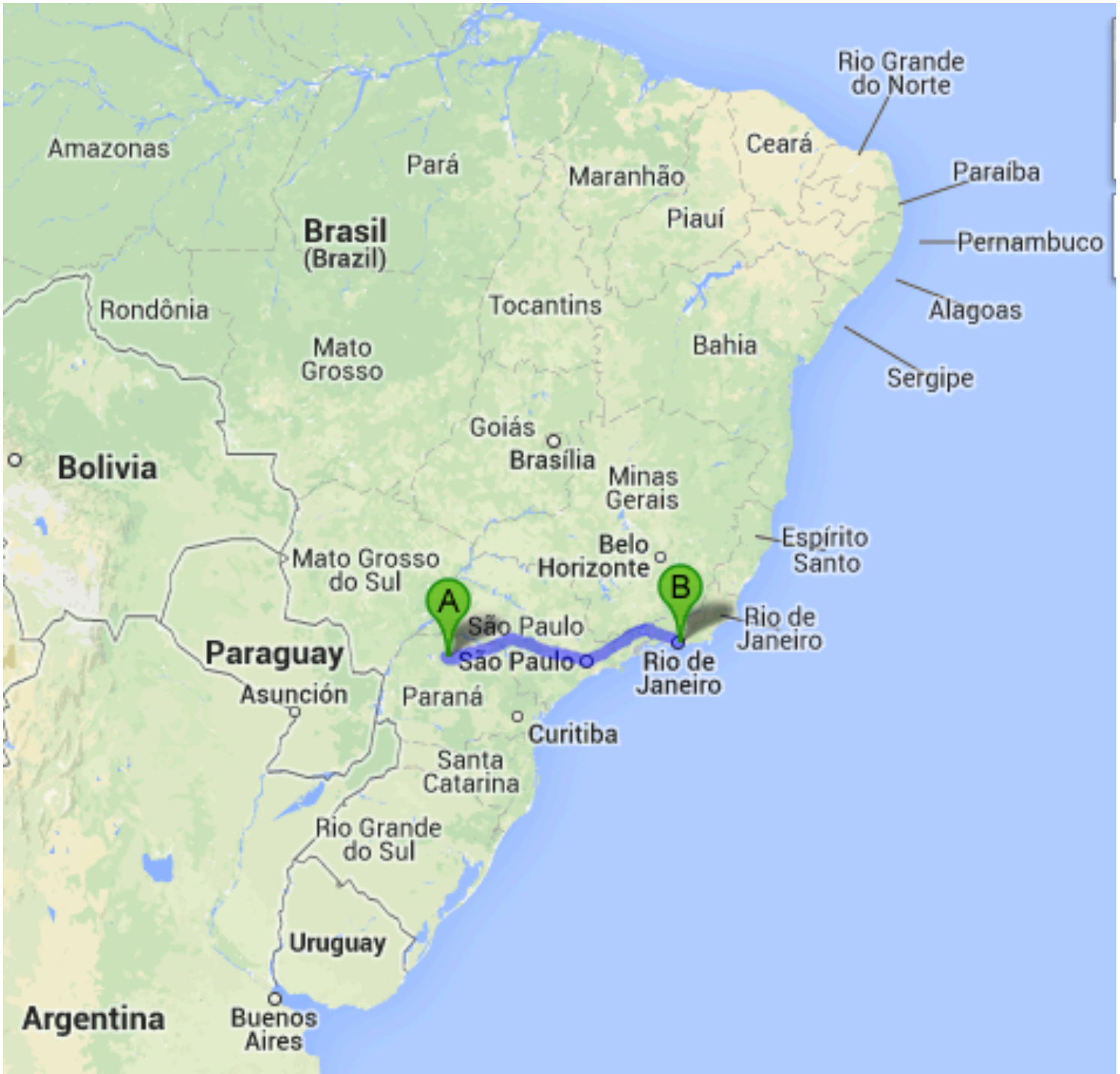
Universidade Estadual de Maringá

Complex Systems - Foundations and Applications

Rio de Janeiro

31 October 2013


Rio Grande do Norte
Amazonas
Ceará
Pará
Maranhão
Paraíba
Piauí
Brasil
(Brazil)
Pernambuco
Rondônia
Tocantins
Alagoas
Mato Grosso
Bahia
Sergipe
Goiás
Bolivia
Brasília
Minas Gerais
Espírito Santo
Belo Horizonte
Mato Grosso do Sul
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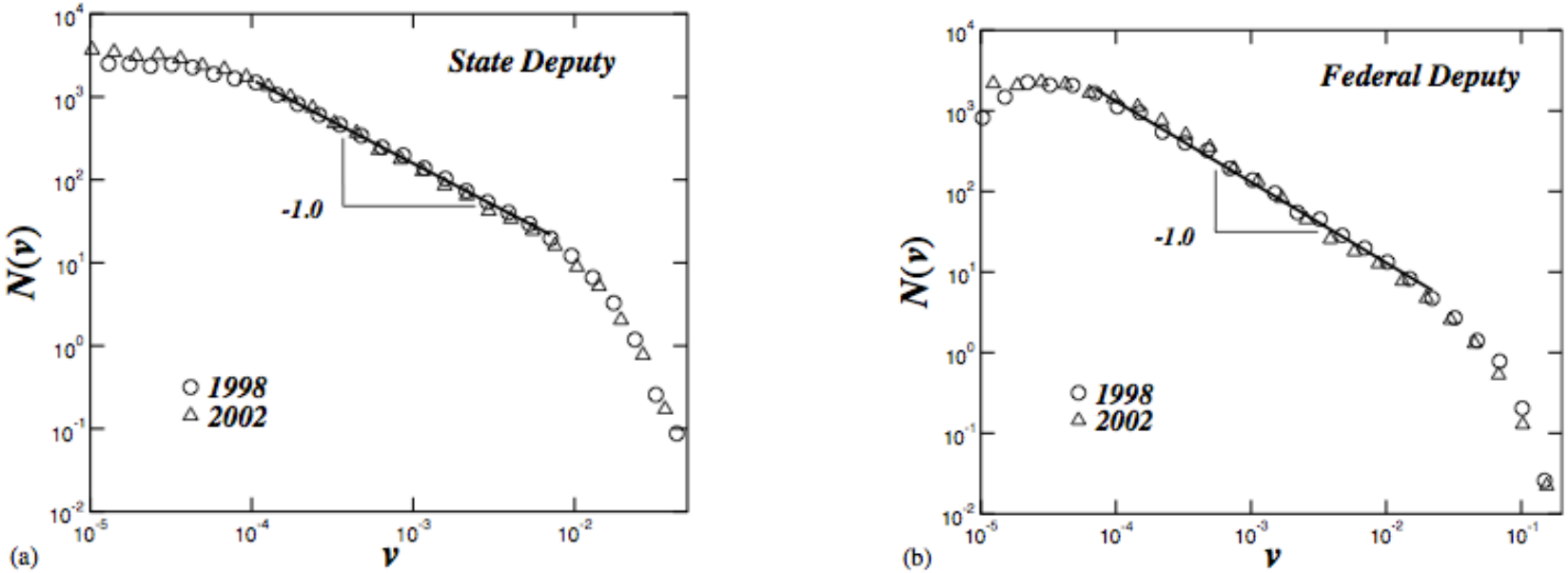
São Paulo
Rio de Janeiro
Paraguay
São Paulo
Rio de Janeiro
Asunción
Paraná
Curitiba
Santa Catarina
Rio Grande do Sul
Uruguay
Argentina
Buenos Aires

Outline

- Vote distribution in proportional elections
- Simulation of vote distribution
- Scaling in proportional elections
- Turnout rates
- Choosing candidates to elections
- Occupation of political positions
- Conclusion

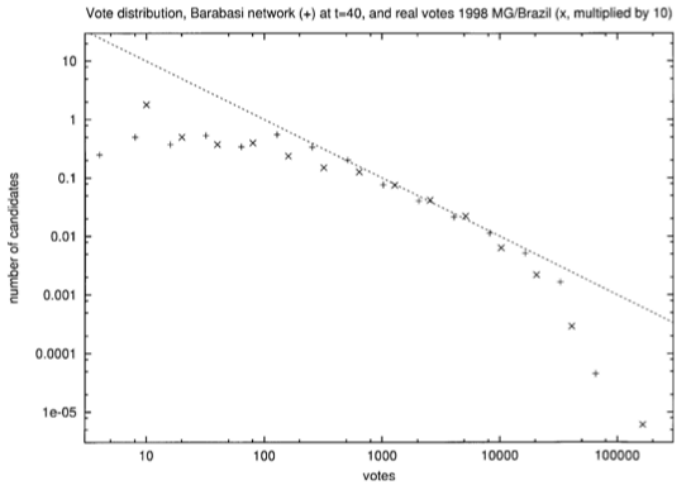
Vote distribution in proportional elections I

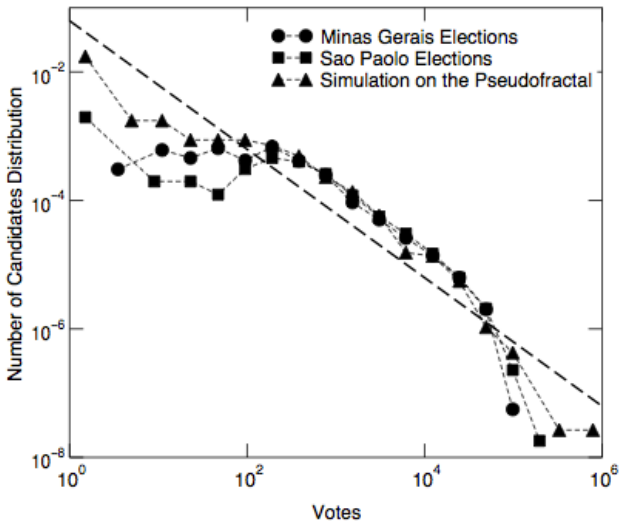


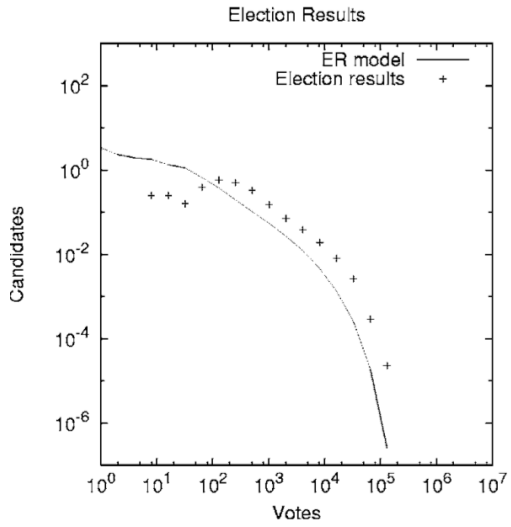
Power law behavior with exponent -1 in the central part. Brazilian elections.

- R. N. Costa Filho , M. P. Almeida, J. S. Andrade, J. E. Moreira, *Scaling behavior in a proportional voting process*, Phys. Rev. E 60 (1999) 1067-1068.
- R. N. Costa Filho, M. P. Almeida, *Brazilian elections: voting for a scaling democracy*, Physica A 322 (2003) 698-700.

Simulations



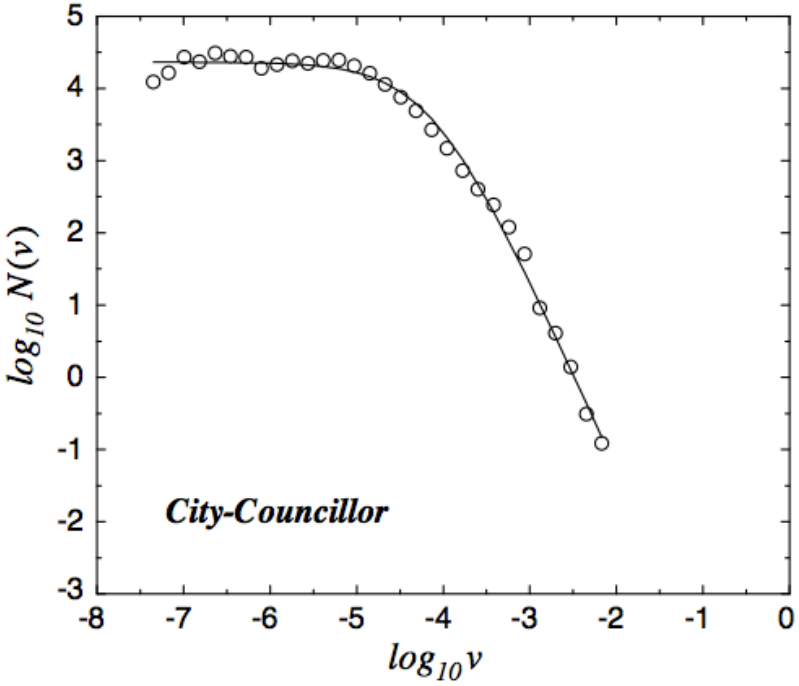




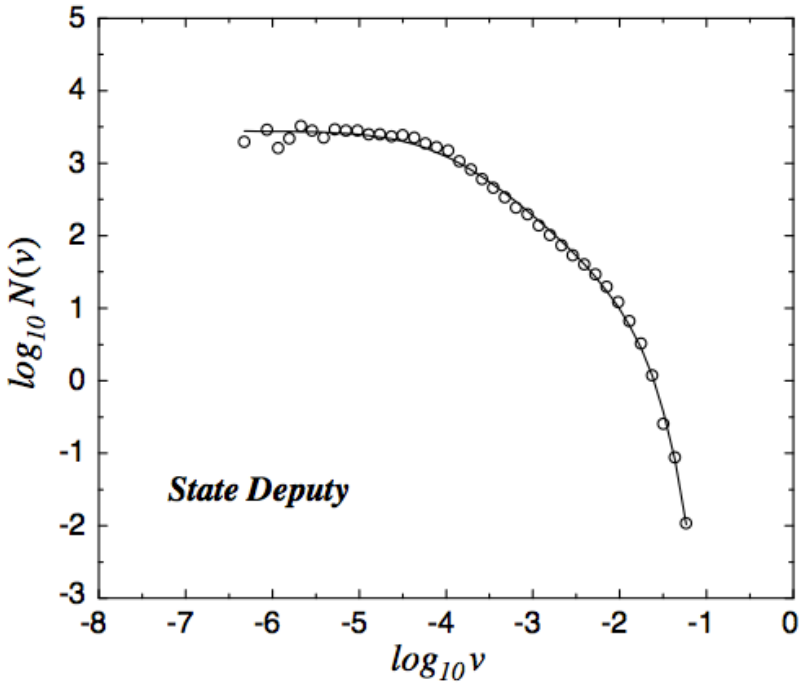
- 500000 nodes on a Brabási network, 1000 candidates, 40 steps. Minas Gerais data.
- Pseudo-fractal network (21,253,732 nodes and 1144 candidates).
  Minas Gerais and São Paulo data.
- Erdös Rényi network. São Paulo data.

- A. T. Bernardes, D. Stauffer, J. Kertész, *Election results and the Sznajd model on Barabási network*, Eur. Phys. J. B 25 (2002) 123-127.
- M. C. González, A. O. Sousa, H. J. Herrmann, *Opinion formation on a deterministic pseudo-fractal network*, Int. J. Mod. Phys. C 16 (2004) 45-57.
- G. Travieso, L. F. Costa, *Spread of opinions and proportional voting*, Phys. Rev. E 74 (2006) 036112.

Vote distribution in proportional elections II



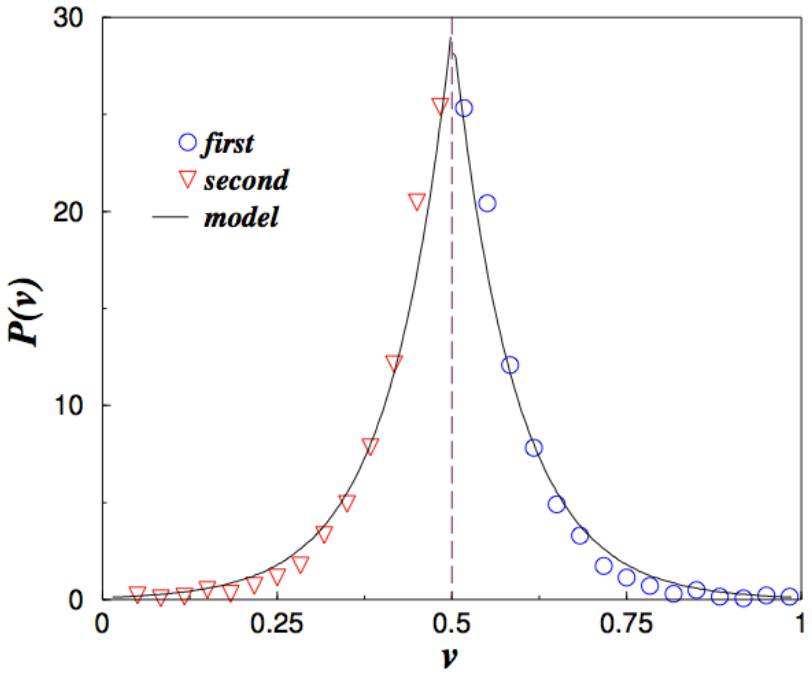
A q-exponential

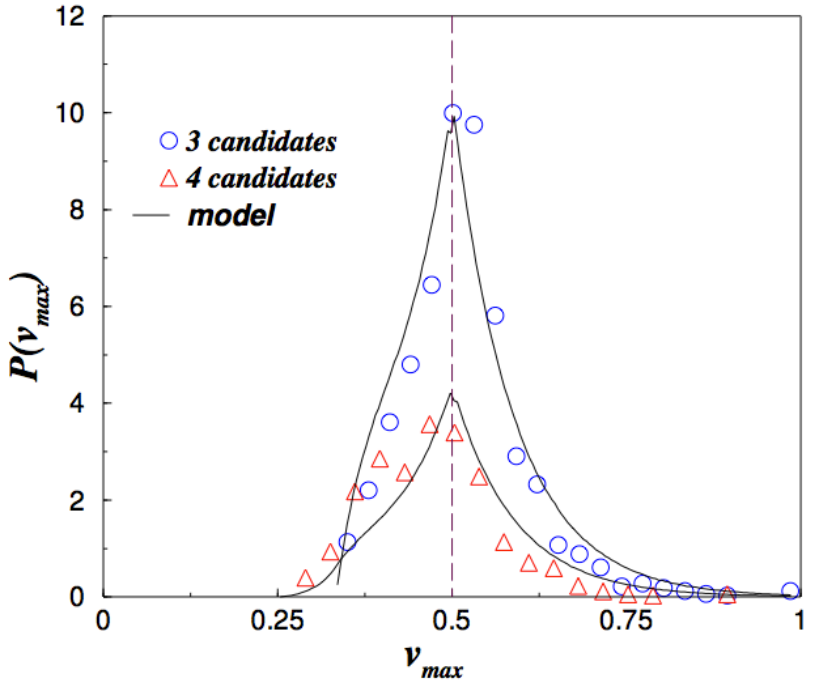


A generalized q-exponential

- M. L. Lyra, U. M. S. Costa, R. N. Costa Filho, J. S. Andrade, *Generalized Zipf's law in proportional voting processes*, Europhys. Lett. 62 (2003) 131-137.

Mayor elections I

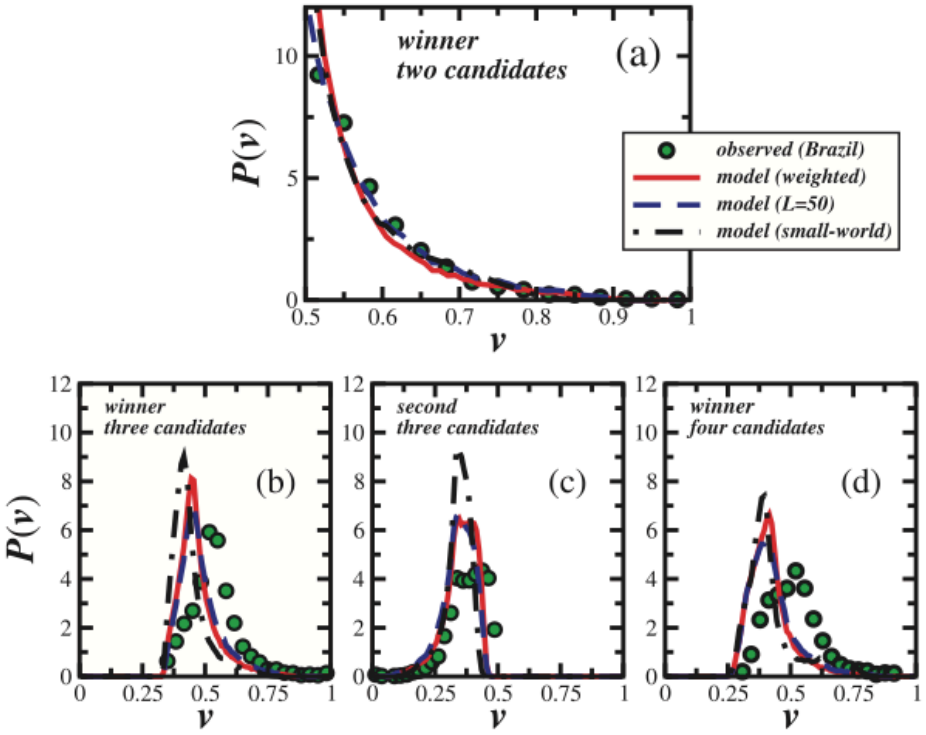




Histograms of voting fraction for mayor elections of Brazilian cities in 2004.
Continuous lines: a fragmentation model.

- L. E. Araripe, R. N. Costa Filho, H. J. Herrmann, J. S. Andrade, *Plurality voting: the statistical laws of democracy in Brazil*, Int. J. Mod. Phys. C 17 (2006) 1809-1813.

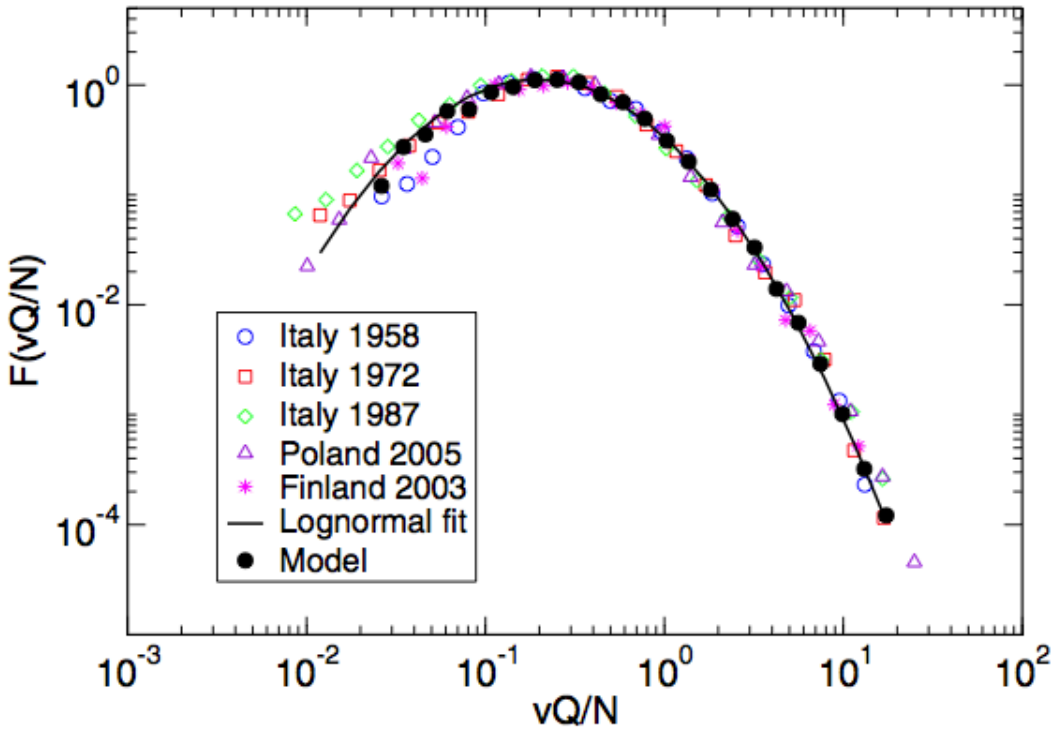
Mayor elections II



Model (continuous lines):
q-states (candidates) Potts model with an external field (polls impact).

- N. A. M. Araújo, J. S. Andrade, H. J. Herrmann, *Tactical voting in plurality elections, PLoS ONE 5 (2010) e12446.*

Scaling in proportional elections



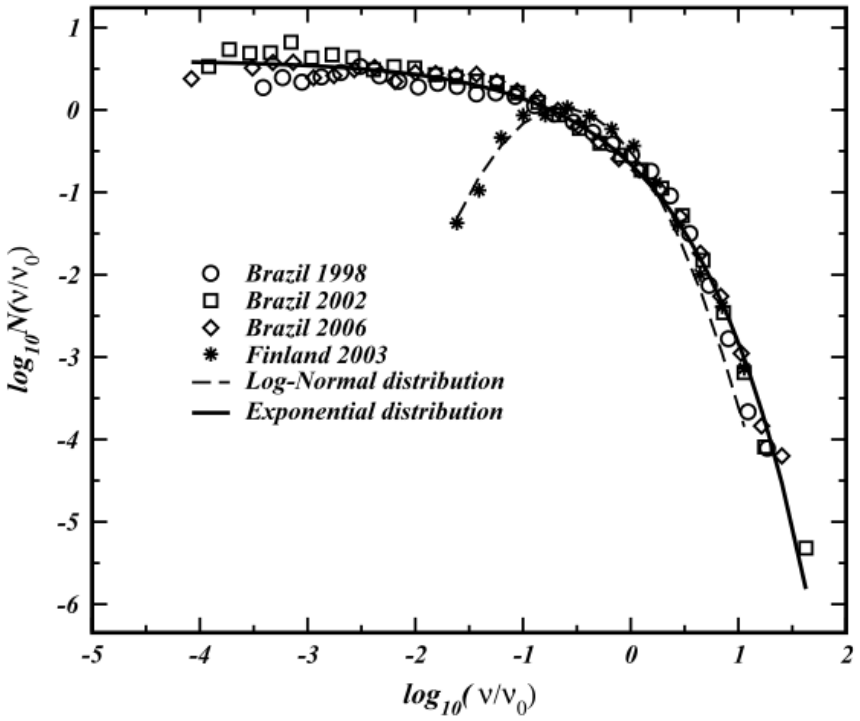
v → number of votes of a candidate

Q → number of candidates of a party

N → total number of votes of a party

- S. Fortunado, C. Castellano, Scaling and universality in proportional elections, Phys. Rev. Lett. 99 (2007) 138701.

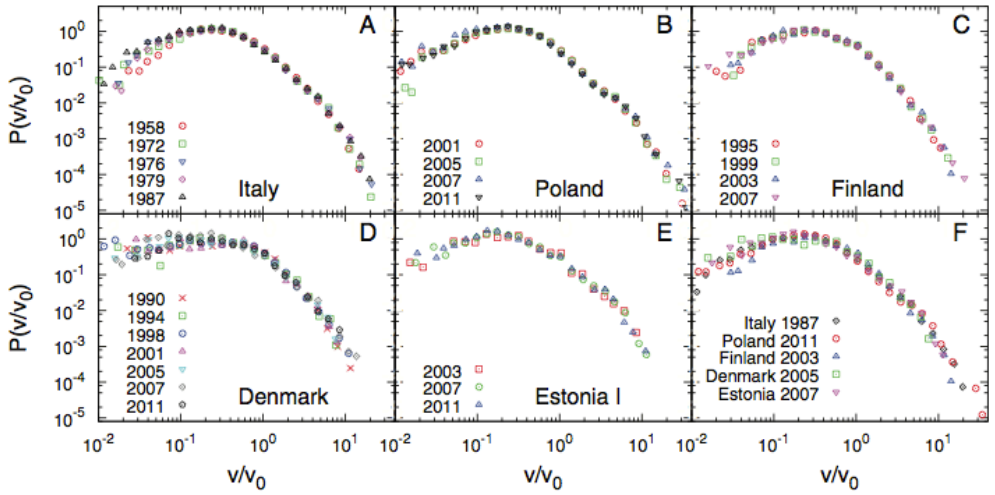
Scaling in proportional elections

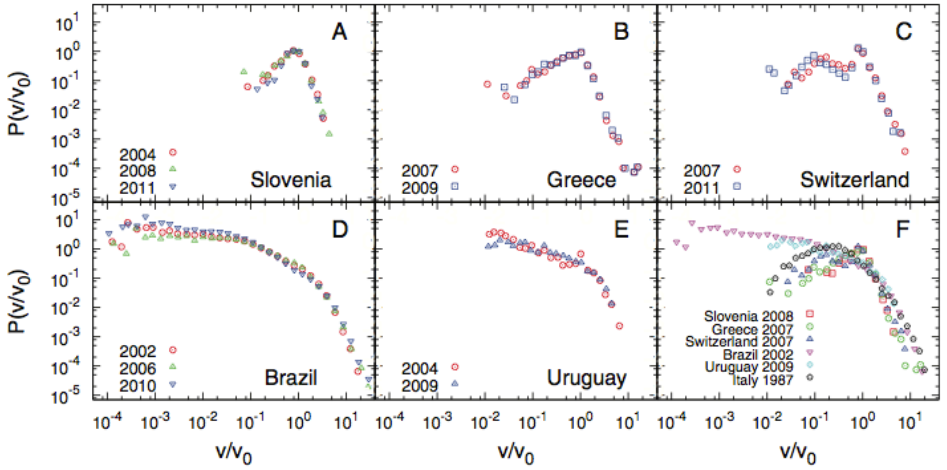


$vQ/N = v/v_o$

- L. E. Araripe, R. N. Costa Filho, *Role of parties in the vote distribution of proportional elections*, Physica A 388 (2009) 4167-4170.

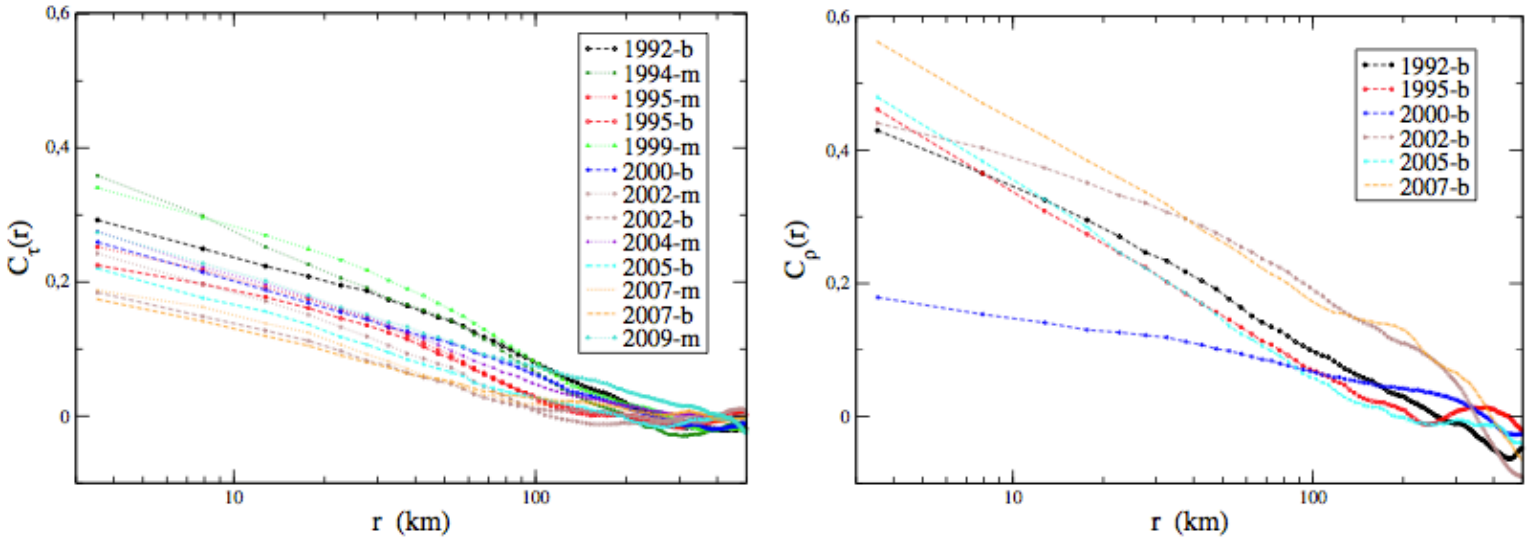
Scaling in proportional elections: general scenario





- A. Chatterjee, M. Mitrovic, S. Fortunato, *Universality in voting behavior: an empirical analysis*, Sci. Rep. 3 (2013) 1049.

Turnout rates



Number of actual voters → N_a

Registered voters → N

Turnout rate → $p = N_a/N$

Logarithmic turnout rate → $\tau = \ln(p/(1-p))$

Spatial correlation → $C_T(r)$

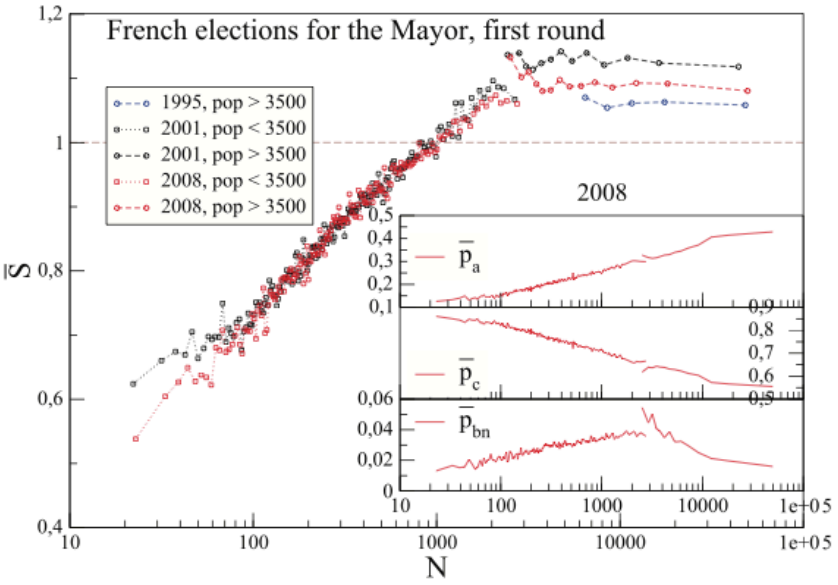
- C. Borghesi, J. P. Bouchaud, *Spatial correlations in vote statistics: a diffusive field model for decision-making*, Eur. Phys. J. B 75 (2010) 395-404.
- C. Borghesi, J.-C. Raynal, J.-P. Bouchaud, *Election turnout statistics in many countries: similarities, differences, and a diffusive field model for decision- making*, PLoS ONE 7 (2012) e36289.

Turnout rate model

$$\frac{\partial \phi(\mathbf{R}, t)}{\partial t} = D\Delta\phi(\mathbf{R}, t) + \eta(\mathbf{R}, t),$$

$$C_\phi(r) = \frac{\langle \phi(r)\phi(0)\rangle}{\langle \phi(0)^2\rangle} \approx -\Lambda^2 \ln \frac{r}{L}, \qquad l_c \ll r \ll L.$$

Involvement of municipalities



Number of abstentionists → N_a

Votes in favor of candidates → N_c

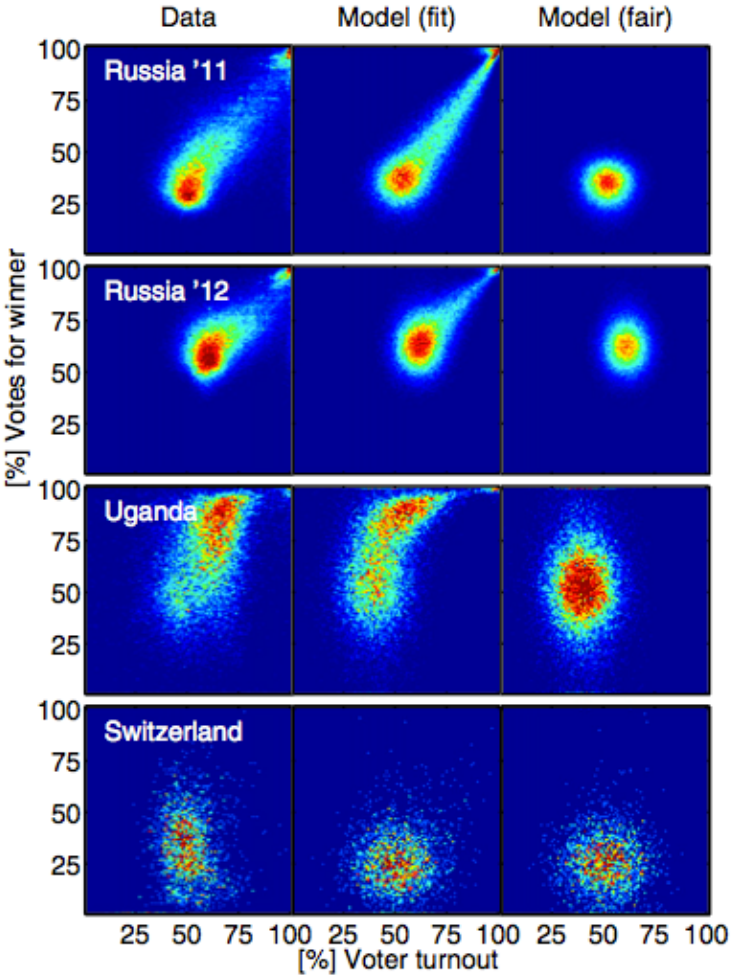
Blank and null votes → N_{bn}

$$p_a = \frac{N_a}{N}, \quad p_c = \frac{N_c}{N}, \quad p_{bn} = \frac{N_{bn}}{N}$$

$$S(p_a, p_c, p_{bn}) = -p_a \log p_a - p_c \log p_c - p_{bn} \log p_{bn}$$

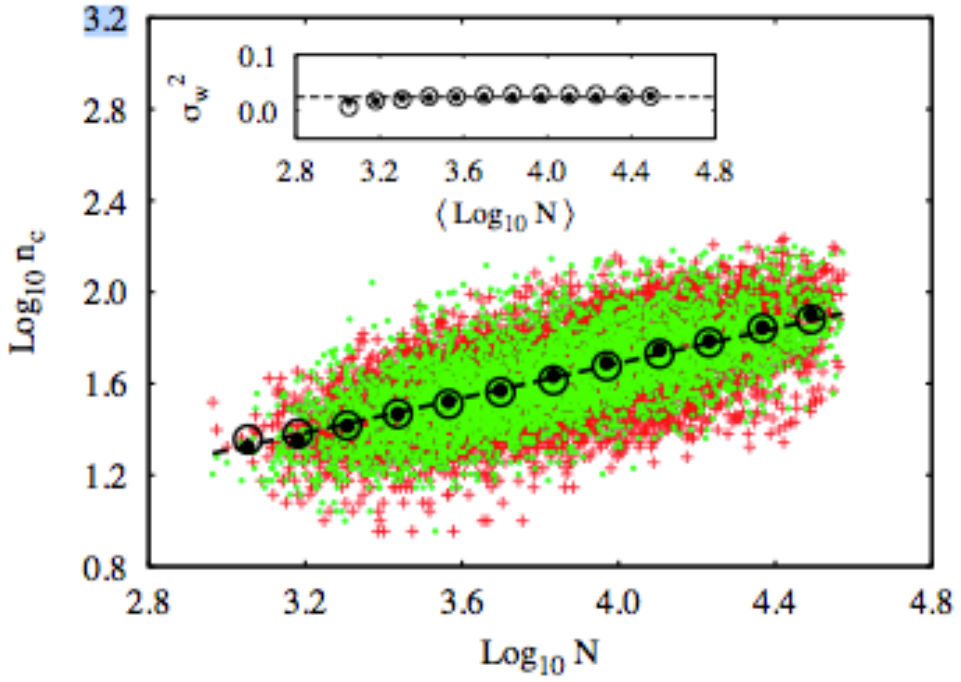
- C. Borghesi, J. Chiche, J.-P. Nadal, *Between order and disorder: a 'weak law' on recent electoral behavior among urban voters*, PLoS ONE 7 (2012) e39916.

Election irregularities



- P. Klimek, Y. Yegorov, R. Hanel, S. Thurner, *Statistical detection of systematic election irregularities*, PNAS 109 (2012) 16469-16473.

Choosing candidates for elections



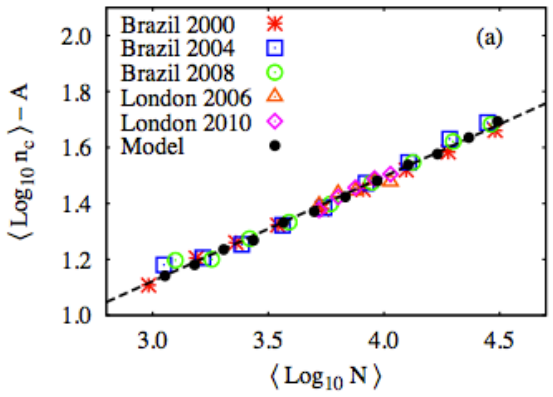
Number of candidates for a city council → n_c

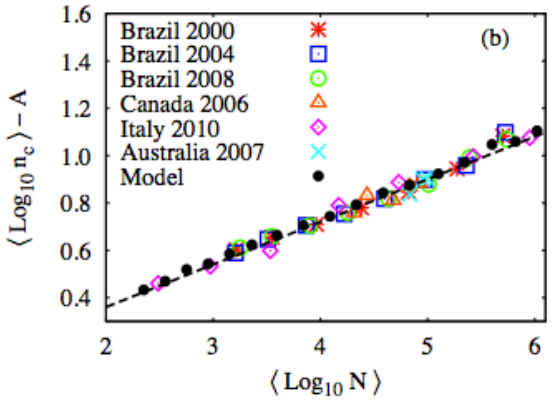
Number of voters → N

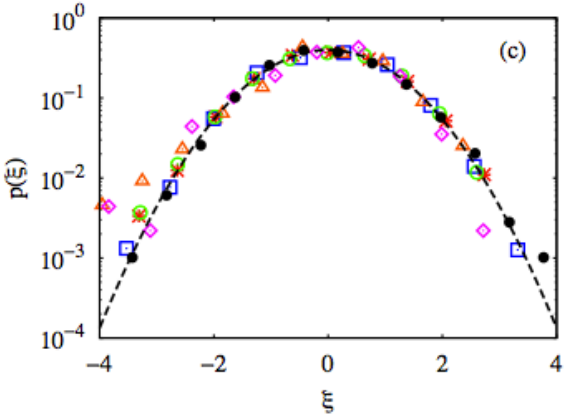
2008 Brazilian case ≈ 5,500 cities

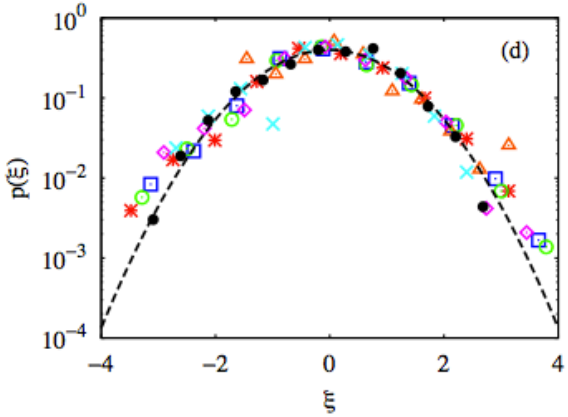
- M. C. Mantovani, H. V. Ribeiro, M. V. Moro, S. Picoli Jr., R. S. Mendes, *Scaling laws and universality in the choice of election candidates*, Europhys. Lett. 96 (2011) 48001.

Choosing candidates for elections









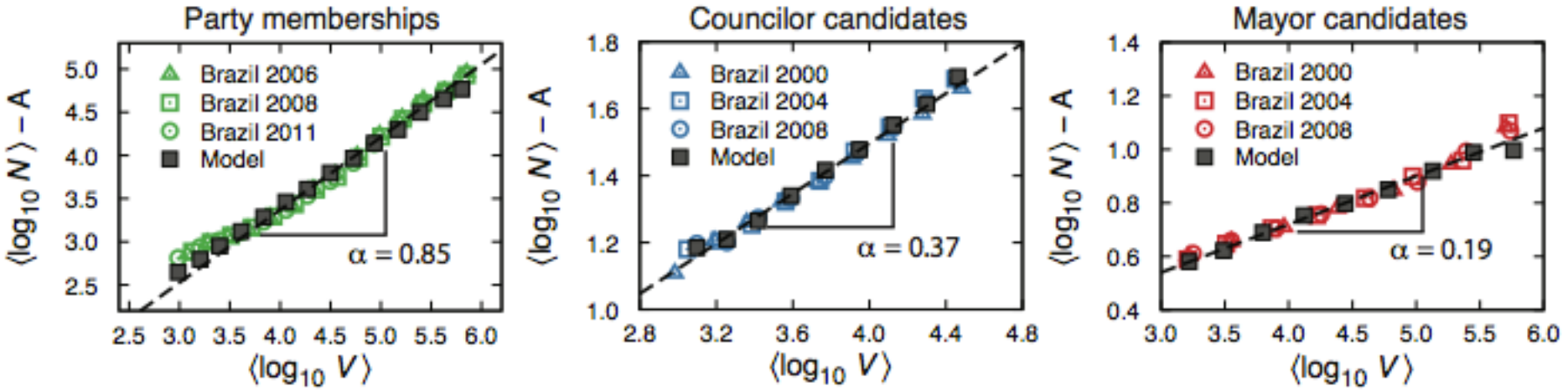
Model:
multiplicative process

$$n_c = \mathcal{A}\ \zeta(N)\ N^{\alpha}$$

City council elections (multi-member) exponent ≈ 0.36

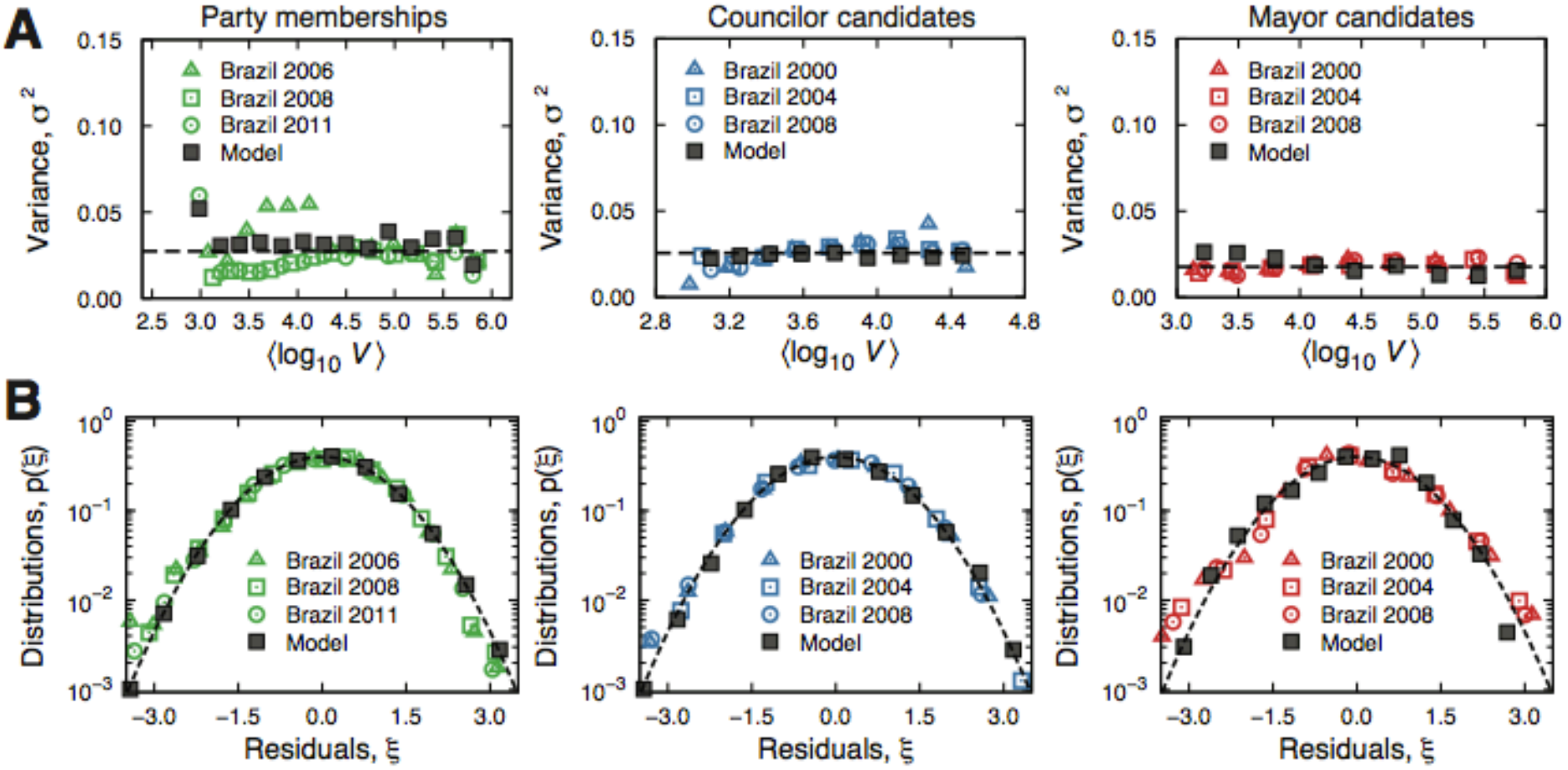
Mayor elections (single-member) exponent ≈ 0.18

Role of the political position

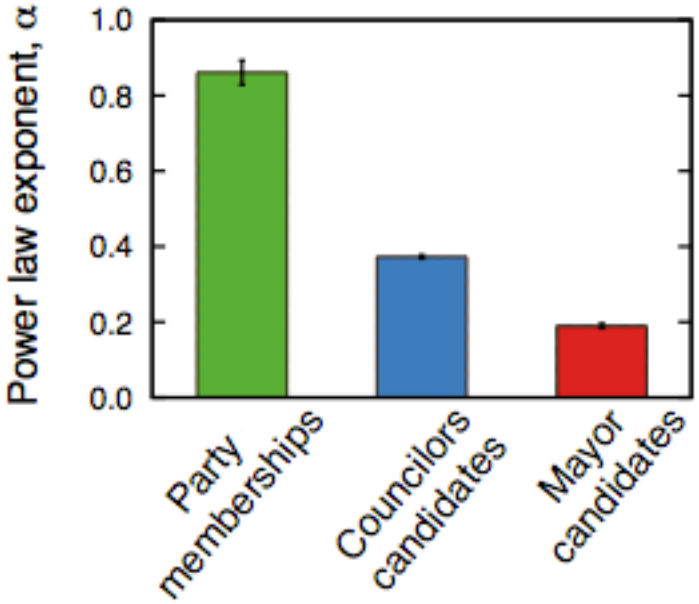


- M. C. Mantovani, H. V. Ribeiro, E. K. Lenzi, S. Picoli Jr.,R. S. Mendes, *Engagement in the electoral processes: scaling laws and the role of the political position*, Phys. Rev. E 88 (2013) 024802.

Role of the political position



Role of the political position



- Exponents decrease with the importance of the political position.

Collaborators

http://www.pfi.uem.br/complex/