

Supplementary Information

Targeted Position Games: A Framework for Strategic Rank Optimization in Competitive Environments

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Contents: Supplementary Methods; Figures S1-S2; Data dictionary and replication notes.

Companion workbook: TPG_SuppData.xlsx (all source data).

Data Availability

All synthetic data and code used to generate the figures and numerical results are provided in this Supplementary Information and in the companion Excel workbook TPG_SuppData.xlsx. Third-party datasets referenced for illustration are under license and are not redistributed here; they can be obtained from their providers with appropriate permissions or from the authors upon reasonable request.

Supplementary Methods

Ranking and Tie-Break: Scores are ordered descending; ranks are 1=best. Ties receive the average rank.

Figure S1 Simulations: $n=6$; baseline scores proportional to $(n - \text{target} + 1)$; Gaussian noise $\sigma=0.35$; 4,000 draws; seed fixed.

Overlap case duplicates target rank 1; avoidance case reduces one overlapping player's baseline by 0.75.

Overlap Dashboard (Figure S2): $n=3$, actions $\{L,H\}$ with scores $L \rightarrow 1$, $H \rightarrow 2$. For each target case we draw 1,000

high-effort costs $k \sim U[0,1]$ and test PSNE existence by brute force over 2^3 profiles.

Lower bound on misalignment is

$\min \sum |R_i - t_i|$ across the same profiles.

PL Threshold Grid (Appendix A): For $\theta = \exp(h/\beta)$ in $[1.05, 3.0]$ and third-player weight c in $[0.5, 3.0]$, we compute

$$k^*(\theta, c) = [c^2(\theta-1) + 3c(\theta^2-1) + (\theta^2-\theta)] / [2(c^2\theta + c^2 + c\theta^2 + 2c\theta + c + \theta^2 + \theta)].$$

Figure S1 — Rank Deviation Density (Distinct targets)

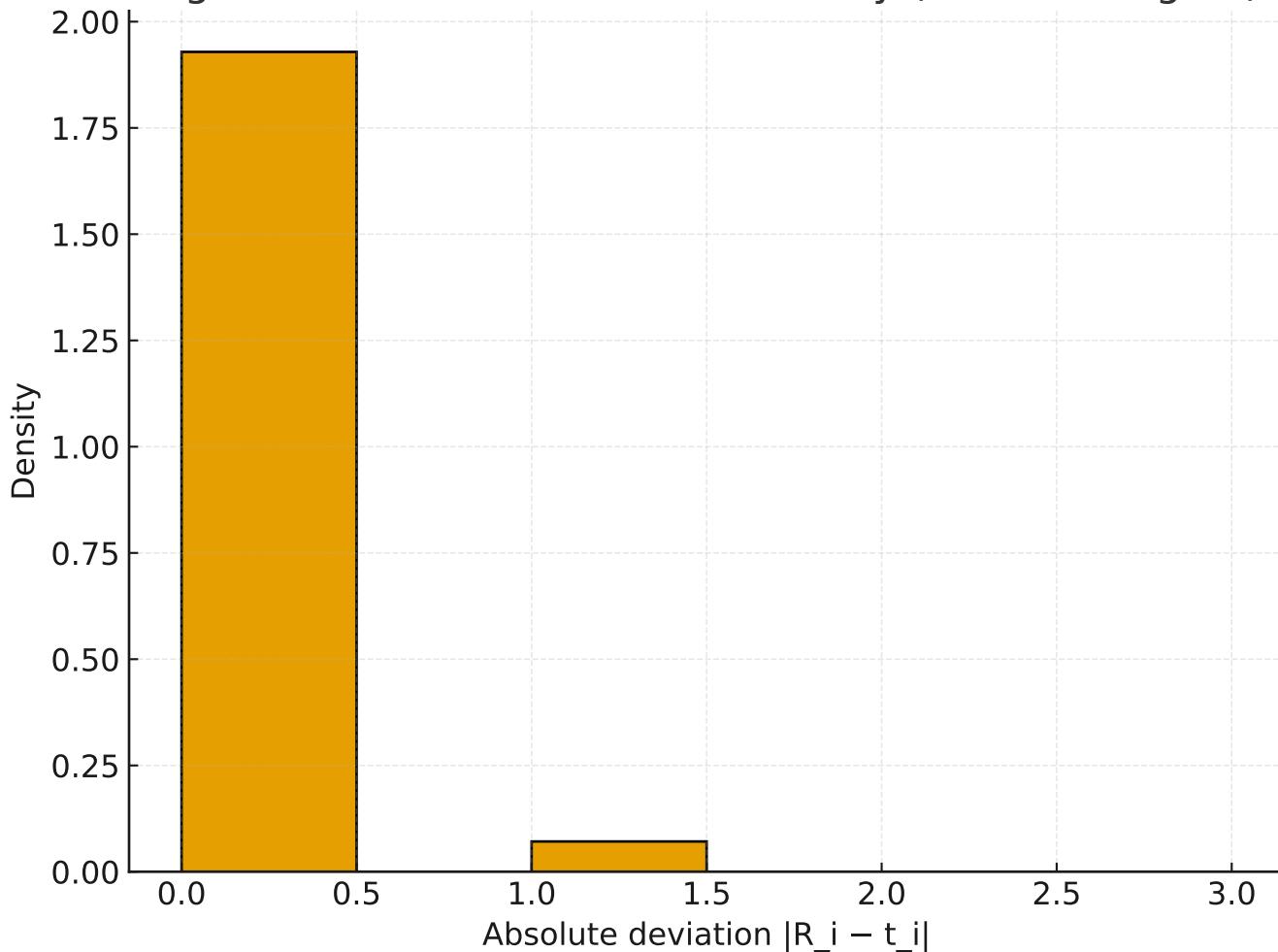


Figure S1 — Rank Deviation Density (Overlap at top (two players target 1))

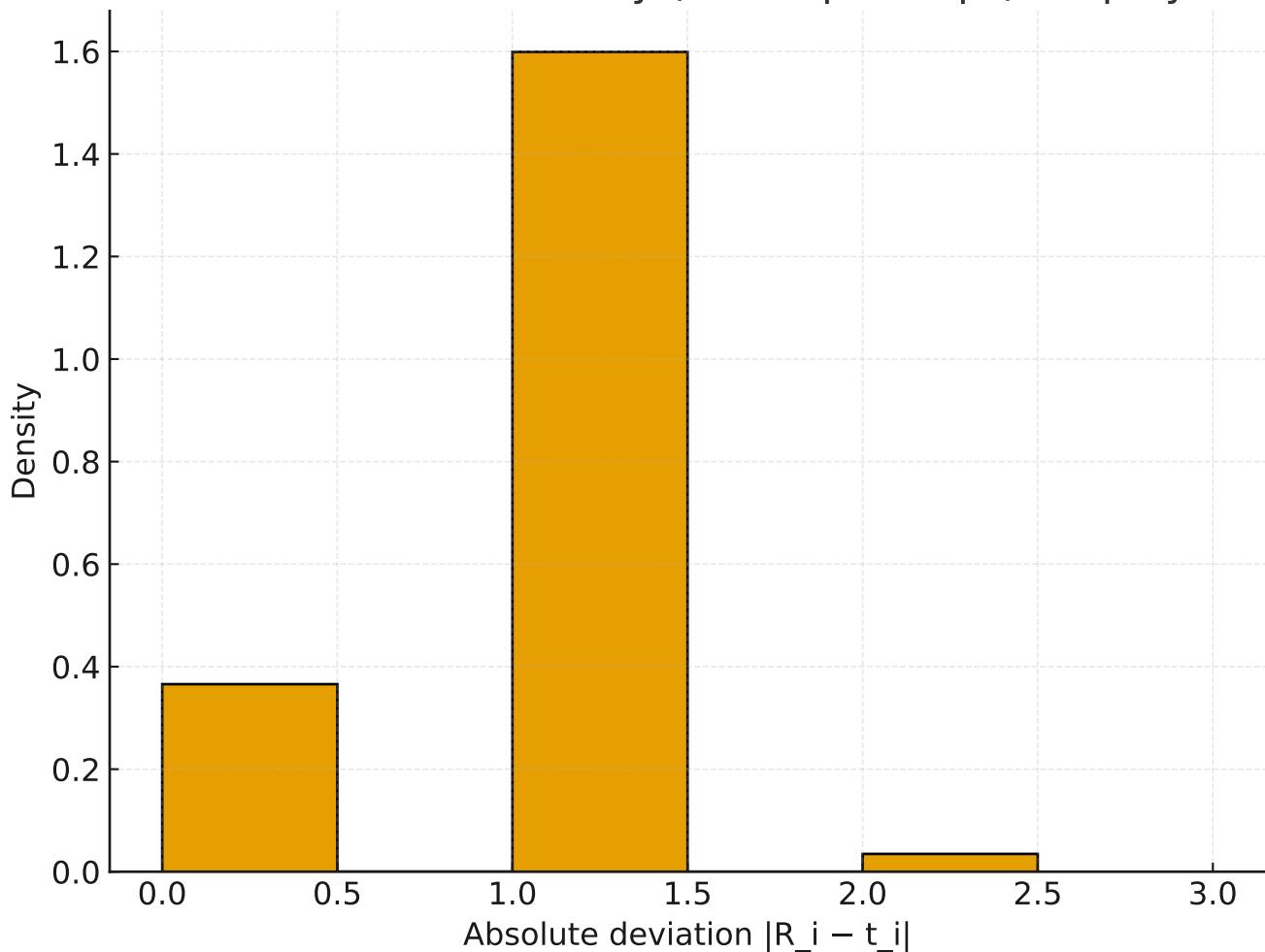


Figure S1 — Rank Deviation Density (Overlap + mild avoidance)

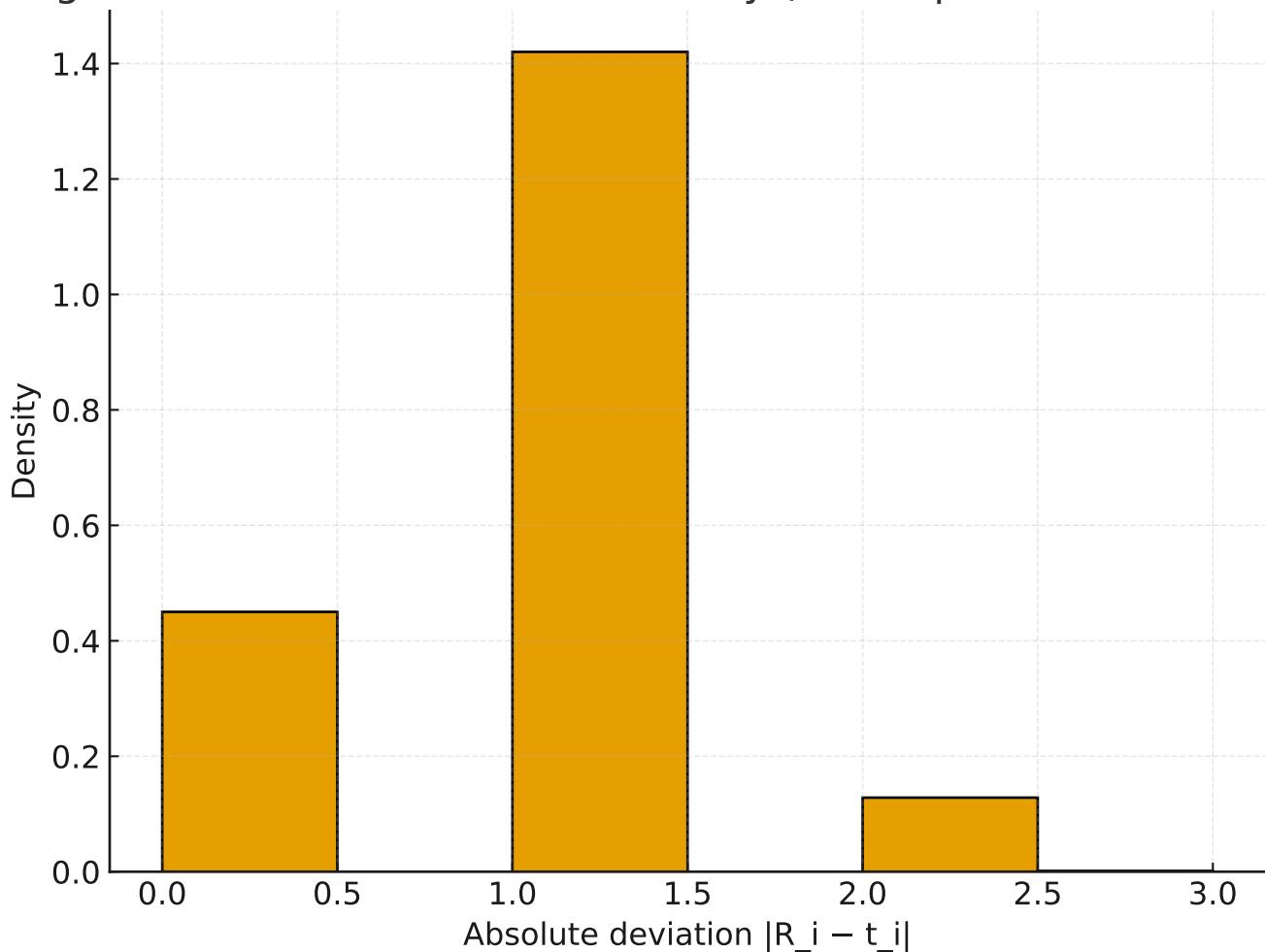


Figure S2a — PSNE Frequency vs Overlap Density ρ ($n=3$)

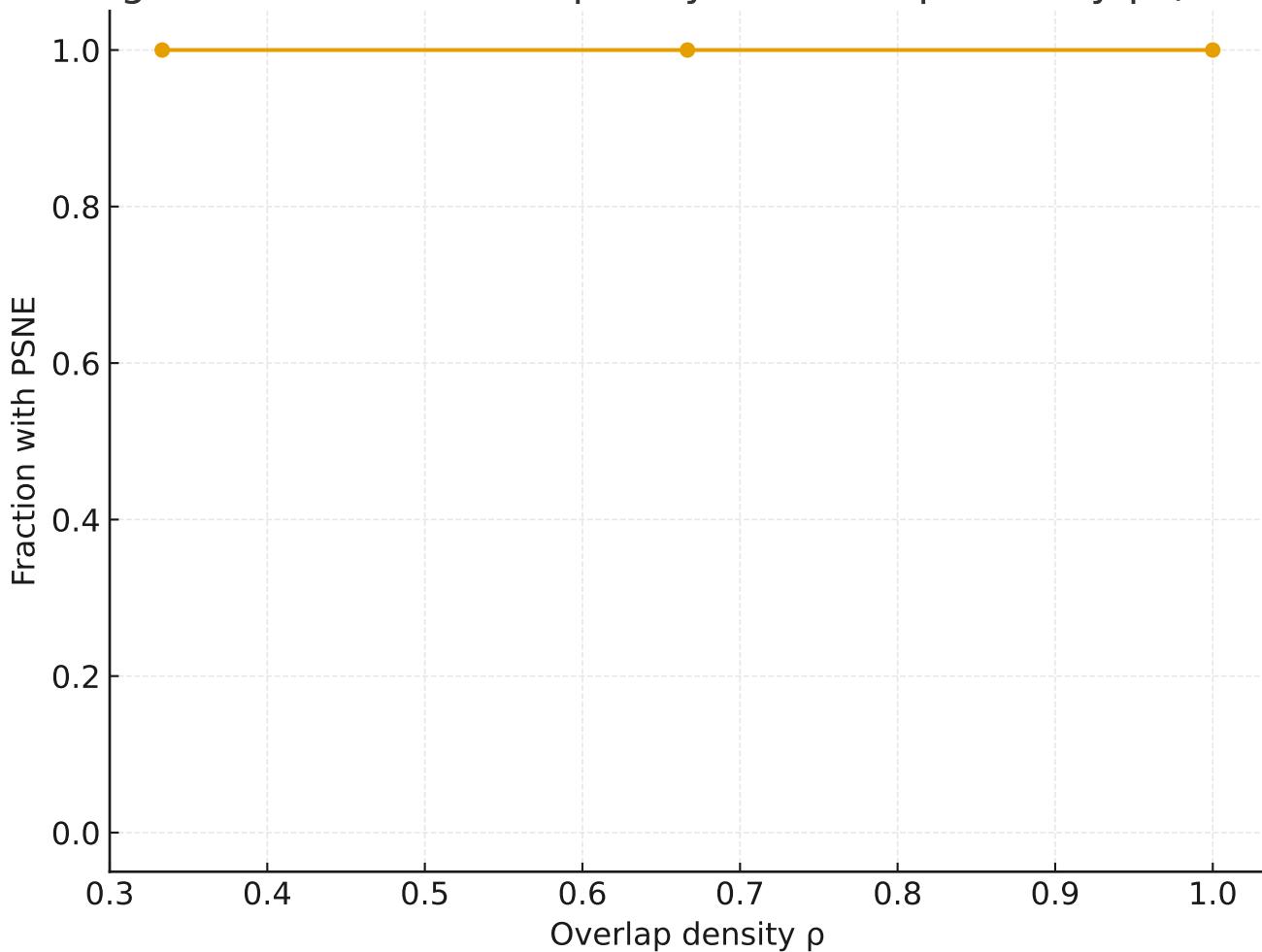
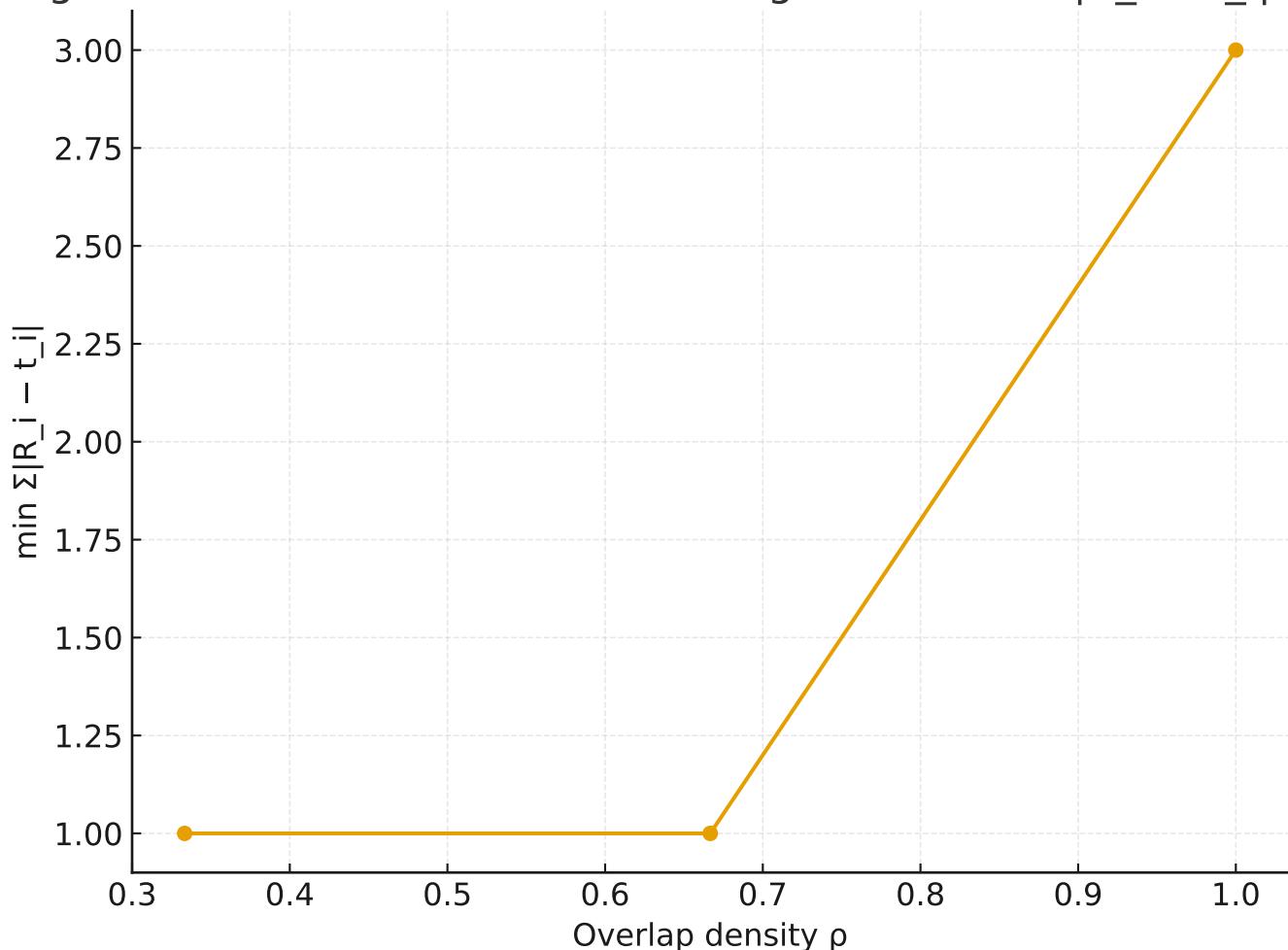


Figure S2b — Lower Bound on Misalignment: $\min \sum |R_i - t_i|$ (n=3)



Data Dictionary & Replication Notes

- rank_densities (Excel Sheet): scenario, n, sigma, seed, abs_deviation — per-agent $|R_i - t_{ij}|$.
- psne_freq_vs_rho (Sheet): case_name, rho, k_samples, psne_count, psne_frequency.
- min_total_dev_vs_rho (Sheet): case_name, rho, min_total_deviation.
- pl_threshold_grid (Sheet): theta, c, k_star.
- table_2_1_overlap (Sheet): actions (a1,a2,a3), ranks (r1,r2,r3), cost-free utilities (u1,u2,u3).

Environment: Python 3.10+, numpy, pandas, matplotlib; random seeds fixed. See README in the data package.