On Manipulation In Prediction Markets When Participants Influence Outcomes Directly

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**Prediction Market**
- Online betting platform:
  - Elicits diffuse private information.
  - Produces collective forecast.
- Popular method of implementation: market scoring rule[1].

**Market Scoring Rule (MSR)**

*Proper Scoring Rule:*
- Realized value of random variable $ac_0^*$
- Informant’s reported estimate of $ac_0^*$
- Assigned score $s_r(a, c_0^*)$: strictly proper if $E_p[loge_r] = \arg\max_{a} E_{p}[s_r(a, c_0^*)]$.
- $\theta$: informant’s true (subjective) probability distribution over $a$.

**Examples:**
- Logarithmic: $s_r(a, c_0^*) = a c_0^* (1 - a) \log(1 - r)$
- Quadratic: $s_r(a, c_0^*) = a^2 - (a - c_0^*)^2$
- Spherical: $s_r(a, c_0^*) = (a + (1 - a)(1 - c_0^*)) / \sqrt{1 + (1 - r)}$

**Manipulation incentives**

*What if agents have incentives extraneous to the market?* 
- *Price Manipulation*
  - If agents can take extra-market actions that influence the outcome, the market seeks to predict?

*Outcome Manipulation*

*Examples:*
1. Instructor Rating Markets[2]: Students in a class voted their instructor up or down at the end of a two-week period during which they participated in a prediction market to forecast the fraction of up-votes received by the instructor.
2. A software engineer working on a product can participate in its release date market.
3. A referee can take part in a betting market for a basketball match.

**Future research directions**

- Extension to
  - More general scoring rules
  - Non-MSR market mechanisms
  - Other liquidation values (e.g., weighted average of “votes”)
  - Subsidy mechanism for “voting” stage to restore incentive compatibility[3].

**References**