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Do prediction markets aid defenders in a weak-link contest?

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ABSTRACT

Laboratory experiments have demonstrated that prediction market prices weakly aggregate the disparate information of the traders about states (moves) of nature. However, in many practical applications one is attempting to predict the move of a strategic rival. This is particularly important in aggressor–defender contests. This paper reports an experiment where the defender may have the advantage of observing a prediction market on the aggressor's action. The results of the experiments indicate that: the use of prediction markets does not increase the defender's win rate; prediction markets contain reliable information regarding aggressors' decisions that is not being exploited by defenders; and the existence of a prediction market does not alter the behavior of the aggressor whose behavior is being forecast.

1. Introduction

Prediction markets have gained popularity in recent years as a means of aggregating diversely held information. Chen and Plott (2002) implement prediction markets for sales forecasts at Hewlett-Packard Corporation (HP) and report that these markets outperform more traditional statistical forecasts. Cowgill et al. (2009) document that internal prediction markets at Google perform well for forecasting new office openings, launch dates, etc. Other effective prediction markets include those for movie box office receipts (Pennock et al., 2001), election outcomes (Berg and Rietz, 2003), outbreaks of contagious diseases (Polgreen et al., 2007) and slaughtered cattle (Gallardo and Heath, 2009). Still there remain many more applications where prediction markets could be utilized, but are not (see Wolfers and Zitzewitz, 2004). For example, Hahn and Tetlock (2005) propose using prediction markets to set monetary policy. After the terrorist attacks of September 11, 2011, Policy Analysis Markets (PAM) were proposed by the Defense Advanced Research Projects Agency, but these markets were not implemented due to concerns raised by members of Congress (Pearlstein, 2003; Wyden and Dorgan, 2003).

A common, but generally inaccurate, concern for prediction markets is that they can be easily manipulated (see Deck and Porter, 2013 for a review). Deck et al. (2013) demonstrate that prediction markets can be manipulated, but it is under extreme conditions when traders only get returns from manipulation and have a large bankroll. The other main concern in

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many countries including the United States involves the ambiguous legal status of prediction markets, due to resemblance with gambling. Prior to halting operations in March 2013, Intrade.com operated public prediction markets on a wide range of future events, including politics, economics, and entertainment, but had spun off the now defunct TradeSports.com which focused exclusively of forecasting the outcome of sporting events years earlier. In Arrow et al. (2008) a group of 22 prominent scholars called for government policies, especially gambling laws, to be relaxed in order for decision makers to better utilize prediction markets.

Concerns of manipulation and gambling are largely mitigated with internal prediction markets, where only members within an organization can participate using token money given to them (as opposed to Intrade where the general public traded shares using money out of their own pockets). The markets at HP were only open to employees in the fields of marketing and finance (Chen and Plott, 2002). The proposed PAM markets were to be open only to those inside the defense community. Trades on Google's internal market are denoted in Goobles (Cowgill et al., 2009). Absent the two main concerns of manipulation and gambling, it is easy to see why there are many advocates for increased reliance on prediction markets given their demonstrated success in a variety of settings (see for Wolfers and Zitzewitz, 2004).

Despite the rhetoric around prediction market success, these markets are typically quite noisy in the laboratory. As discussed in a recent survey by Deck and Porter (2013), average prices in a period tend to be too high on average and over a series of trading periods the variance in average prices tends to be too small in comparison to full information aggregation. Nonetheless, closing prices contain useful information as they correlate positively – although weakly – with the prices that should prevail when information is aggregated, at least after the traders have gained market experience. Even such imperfect prediction markets can provide useful information to market observers (see Oprea et al., 2007). However, unlike previous laboratory experiments where the forecasted event is exogenously determined through a known process, in many naturally occurring settings the activity that is being forecasted involves strategic uncertainty in a game. For example, one can imagine a firm using a prediction market to forecast which market segments a rival is going to target with its advertising budget. The goal is not simply to aggregate this information, but to use the information in allocating the firm's own advertising budget. The same situation would have arisen in the PAM markets where the forecasted activity would have involved the calculated actions of terrorists who were attempting to hide their actions from those in the defense community.

Predicting strategic behavior raises two issues for prediction markets that may be absent in other settings such as those that have been studied in the laboratory. The first is that the type of behavior that is being forecast may change due to the existence of the prediction market. The second is that traders may be more likely to rely upon their own intuition or bias about what the forecasted behavior is likely to be rather than focusing on their private information. For example, a trader forecasting a rival's advertising efforts in a particular market may be subject to a confirmation bias and overweight their prior belief that the rival is going to invest heavily on a certain market segment. A defense analyst may ignore private information suggesting one target is unlikely to be attacked out of a conviction that it is the obvious choice of target.

The current paper explores the effectiveness of internal prediction markets where the forecasted event is a strategic choice in a game between the market observer and the party whose action is being forecasted. Formally, the game is modeled as a weak-link contest, a type of game that has received considerable behavioral and theoretical attention recently (see Dechenaux et al., 2014 and Kovenock and Roberson, 2010 for comprehensive reviews of the respective literatures). The paper is organized as follows. The next section discusses background details. Section 3 describes the experimental design and Section 4 provides the behavioral results. A final section offers a concluding discussion.

2. Background discussion

Contests have been used to study a variety of topics: lobbying (Krueger, 1974; Tullock, 1980; Snyder, 1989), patent races (Fudenberg et al., 1983; Harris and Vickers, 1985, 1987), and military strategy (Borel, 1953; Borel and Ville, 1938; Gross, 1950; Gross and Wagner, 1950; Friedman, 1958). The essential components of a contest are that each player makes an unrecoverable investment in the hopes of earning a prize, the allocation of which depends in part on the set of realized investments. One common approach is the so-called all-pay auction where the party investing (or bidding) more wins with certainty.

One can extend a single all-pay auction to a contest where the ultimate winner depends on combinations of outcomes in individual subcontests. Many sporting champions are determined by playing a best of five or best of seven series. New products often involve a series of patents rather than a single patent. Firms often compete with each other in multiple markets. Terrorists have many possible targets. The classic Colonel Blotto game (Borel, 1953) is a multi-contest game where the two militaries simultaneously allocate discrete numbers of soldiers among different battlefields. A battle is won by the military with more troops present and the war is won by the military that wins the most battles.

Despite the relatively simple set up, Colonel Blotto style games are quite complex (see Hart, 2008 for solutions to symmetric games). Other recent work in the area has allowed for asymmetric budgets, an opportunity cost of resources, continuous investment, and non-majority win rules (see Kvasov, 2007; Laslier, 2002; Laslier and Picard, 2002; Roberson, 2006; Szentes and Rosenthal, 2003a,b). Derek and Konrad (2007) and Golman and Page (2009) consider a setting where one side needs to win every battle to win the war while the other side only needs a single victory. This structure where the whole game is lost if a single subcontest is lost is referred to as a weak-link game drawing on the analogy that a chain is only as strong as its weakest link. In the laboratory, Avrahami and Kareev (2009) examine Colonel Blotto games with symmetric and asymmetric budgets. The results are qualitatively consistent with the theoretical predictions. Cinar and Göksel (2012) also report