Manipulating Political Stock Markets: A Field Experiment and a Century of Observational Data*

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Abstract

Political stock markets have a long history in the United States. Organized prediction markets for Presidential elections have operated on Wall Street (1880-1944), the Iowa Electronic Market (1988-present), and *TradeSports* (2001-present). Proponents claim such markets efficiently aggregate information and provide forecasts superior to polls. An important counterclaim is that such markets may be subject to manipulation by interested parties. We analyze this argument by studying alleged and actual speculative attacks— large trades, uninformed by fundamentals, intended to change prices— in these three markets. We first investigate the speculative attacks on TradeSports market in 2004 when a single trader made a series of large investments in an apparent attempt to make one candidate appear stronger. Next we examine the historical Wall Street markets where political operatives from the contending parties actively and openly bet on city, state and national races; the record is rife with accusations that parties tried to boost their candidates through investments and wash or phantom bets. Finally we report the results of a field experiment involving a series of planned, random investments-- accounting for two percent of total market volume-- in the Iowa Electronic Market in 2000. In every speculative attack that we study there were measurable initial changes in prices. However, these were quickly undone and prices returned close to their previous levels. We find little evidence that political stock markets can be systematically manipulated beyond short time periods.

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I. Introduction

Prediction markets trade contracts with payoffs explicitly linked to future events. An example is a binary option which pays a dollar on the outcome of a specific event, such as a candidate's victory or an on-time product launch. An efficient prediction market aggregates available information, yielding prices that are the best forecast of the event's probability.

Prediction markets are currently the subject of intensive research in fields ranging from economics to political science to computer science (Berg, et al, 2005; Hanson, 1999; Pennock, 2004; Wolfers and Zitzewitz, 2004; Ledyard, 2005). There is also growing interest outside of academia. In the popular press, James Surowiecki (2004) has championed the *Wisdom of Crowds* while in the private sector, Abbott Labs, Corning, Goldman Sachs, Google, Hewlett-Packard, Intel, Lilly, Microsoft, Siemens, and Yahoo! have begun running internal prediction markets. The hope is such markets can aid forecasting and improve decision-making in economic policy, corporate project selection, influenza vaccination and other areas.

However, several theoretical challenges to the efficiency and predictive power of these markets have been advanced. For example Manski (2005) questions the received wisdom that prices can be interpreted as probabilities. In his model, market prices only provide information about the wide interval in which mean beliefs over probabilities lie. The work has generated several responses including Wolfers and Zitzewitz (2005), Gjerstad (2005), and Ottaviani and Sørensen (2005).

Another, perhaps more damaging challenge to the forecasting ability of prediction markets is the possibility that small group of investors could deliberately distort or manipulate prices away from fundamentals for strategic purposes. Stiglitz (2003) criticized the proposed Policy Analysis Market, a heavily publicized futures market on Middle East economic and military events, on the grounds that it "could be subject to manipulation." There were similar charges of manipulation in online prediction markets which we will discuss below. As online markets rise in public visibility, it might become increasingly likely that interested parties would attempt to strategically distort prices to influence real-world outcomes.

This paper investigates the open empirical question of whether manipulation causes important distortions in actual prediction markets. For the purpose of this study, *fundamentals* are any information that influences the underlying value of the contract. A *speculative attack* is defined any trade, uninformed by fundamentals, intended to change prices. A (*successful) manipulation* is a speculative attack that achieves its objective of changing prices.[1]

We analyze speculative attacks, both alleged and actual, in three political stock markets: the 2004 *TradeSports* market for President; the historical Wall Street betting markets for national, state, and city races; and the 2000 Iowa Electronic Market (IEM) for President. Our empirical analysis ranges over a wide terrain, covering both observational data and field experiments, and evaluating evidence from both contemporary and historical prediction markets. We believe this breadth of approach substantially enhances the robustness of our findings.

We find that these speculative attacks initially move prices, but these changes are quickly undone. The online 2004 *TradeSports* political stock market experienced two large price drops in the last months before the election. These drops were due to the large sales of a small group of traders who were purportedly aiming to steer the election to Kerry. While the price moves were large enough to warrant coverage in the *Wall Street Journal*, the effect was short lived and prices returned to their pre-attack level in less than an hour. The historical political markets operated in the late 19th and early 20th centuries, involved millions of dollars in wagers and had a respectable ability to predict the election winner. Political operatives often made large investments in these markets, and the record is filled with accusations that certain trades were executed to make a candidate appear stronger than he really was. While these speculative attacks are associated with a price change, prices return to near their pre-attack level within days. The final set of evidence comes from a field experiment in the 2000 IEM presidential market. We made a series of random investments, totaling about two percent of the total trade volume, to simulate speculative attacks. Our experimental design exploited the fact that the IEM has two markets both linked to the same fundamental (candidate vote share). We varied our

[1]A successful manipulation is usually not possible unless the trades influence the beliefs of other market participants. An investor's *beliefs* are defined with respect to the fundamentals, as well as the future actions and beliefs of other investors.

attacks between attacking a single market and simultaneously attacking both markets. The first case provides a natural control market, allowing us to test various hypotheses about market responses to speculative attacks. The second case might more accurately represent the trades of an insider possessing private information. These attacks led to large initial price changes, but prices typically reverted to their initial level in a few hours. In the case of single market attacks, prices in the control market did not markedly move following the attacks. In total our evidence suggests that manipulating political stock markets is difficult and expensive to do for more than a short period.

The paper has the following form. The next section investigates charges of manipulation in the 2004 *TradeSports* Market. The third section extends the analysis back one century by probing the role of manipulation in the large New York election betting markets, wagering on President, Governor, and Mayoral races between 1880 and 1944. The fourth section takes us from the position of passive outsider observers to active insiders by examining a field experiment involving a planned series of speculative attacks in the 2000 IEM Presidential markets. The final section summarizes our findings from this large and diverse set of data. The appendices include a section relating our concepts and methods to the existing literature.

II. *TradeSports* 2004 Presidential Market

a. Background

TradeSports operates several online prediction markets.[2] It ran the most influential market on the 2004 US Presidential election, which attracted more than $15M in trade volume. Shares in the main election market paid a fixed amount if Bush won, and the prices were scaled between zero and a hundred to give the usual probability interpretation.

Shortly after 2:30 pm (EDT) on Friday, October 15, 2004, the *TradeSports* odds price on the re-election of President Bush began to fall precipitously. From a plateau of

[2] *TradeSports* markets are listed at http://www.tradesports.com. It is part of the Trade Exchange Network which provides an electronic matching service for trading futures on sports, entertainment, legal, and political events. The company, based in Dublin, Ireland, was founded in 2001. Its shares pay $10 upon winning but are quoted between 0 and 100. When share prices are between 6 and 94, or exactly 0 or 100, then TradeSports charges a commission of 0.04 dollars (about 0.8 percent) per shared trades. Outside that range to the extremes the commission rate is 0.02.

54 points at 2:30 pm, the price dropped to 40 by 2:33 pm, bounced back to 50 and then dropped to just 10 points moments later. Thus prices fell by 44 points in just three minutes, suggesting that Bush went from a slight favorite to serious underdog. This sharp drop was the most dramatic of a series of trades that *National Review Online* blogger Donald Luskin soon charged were politically-motivated speculative attacks on Bush futures "to sway the election towards Kerry."[3] Some saw the hand of George Soros behind the October 15 plunge as well as earlier bear raids on Bush. Such rumors gained currency when a *TradeSports* press release, publicized in *Wall Street Journal* and *Time*, confirmed that the large trades of a single investor produced the October 15 price moves.[4] The press release asserted "Bush contract has become the battle ground of wills between a cadre of large, well financed rogue traders seemingly bent on driving down the Bush re-election contract and a growing list of financial traders who think they can predict the outcome of this election."

Figure 1 displays the price and volume during September and October when the purported manipulations occurred. In addition to the October 15 event, the other episode is a 13-point drop in the price of the "Bush Winner" contract over a fourteen minute period around 12 pm EDT on Monday, September 13[5] Figure 2 shows the manipulation events in greater focus (Time in the figures is reported in GMT or four hours later than EDT).

As a rule, the *TradeSports* market appears to quickly incorporate new information. For example, Bush shares fell over 5 points during the Presidential debate on October 8 (October 9 GMT) which many commentators later argued he lost. This suggests that investors are actively monitoring the market, and that placid price periods are not simply due to investor inattention.

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[3]Donald Luskin, "Who's Behind the Bush-Futures Attacks?" *National Review Online*, 18 Oct. 2004, 11:32 AM. http://www.nationalreview.com/nrof_luskin/luskin200410181132.asp. See also the 16 Oct. 2004 entry, "Bush Futures Being Manipulated" in Luskin's own blog, *The Conspiracy to Keep You Poor and Stupid*, http://www.poorandstupid.com/2004_10_10_chronArchive.asp.

[4]"Bids and Offers," *Wall Street Journal*, 22 Oct. 2004, p. C4; and "Let's Make This Vote Interesting, Shall We?" *Time*. 25 Oct. 2004.

[5]Two other trades were also reported as manipulation attempts. However, these occurred at a time when news about the candidates was being revealed (during the second and third Presidential debates) and involved relatively modest price changes. We do not include an analysis if these events in the paper, though in each case prices returned to roughly their pre-manipulation level as with the episodes we study.

b. Results

Through a special agreement with *TradeSports*, we have gained access to real-time trade data. These data include the quantity and price (though not identity of the traders) of every transaction between 10 September and 21 October 2004, a period encompassing the two attacks described above.

An analysis of the attacks using these trade-level data is presented in Table 1. The exact period of the trades is listed in the column headers, and the first four rows summarize the activity during the attacks. The price declines were far higher than was typically observed for such short periods. Over the entire observation period, the average price range is 0.07 over three minute intervals (the length of the second attack) and is 0.25 over fifteen minute intervals (the length of the first attack). The price changes following the attacks, listed in Table 1, are an order of magnitude larger than any other price change in the data. The volume is also heavy, with the share or dollar volumes about a hundred times larger than normal (the average volume per minute is 5.4 shares or $32.10).

It seems unlikely that these episodes were instigated by unusual market conditions. While they did follow periods of slightly higher than average volume, the prior price volatility was relatively low. Prices changed by only 1.5 in the hour prior to attack 1, and not at all in the hour preceding attack 2.

Because volume data is available, we can investigate whether the attacks could have been immediately financially profitable. Row four of Table 1 calculates the net return if the manipulator immediately bought back the shares he had sold, using as data the observed prices following his trades. Recall that if market beliefs are unchanged, the trader will have to buy back shares at the higher, pre-attack price and therefore take a loss. This is just what we see for attack 2, with trader losing over ten percent of his investment. Attack 1, however, allows a four percent gain because prices did not immediately return to their initial level. This value is an upper-bound estimate, because the trader would likely have to re-purchase some of his shares at a price exceeding the observed level (unless he was able to buy all of his shares before those observed makes purchases). Hence in practice even attack 1 would not likely be profitable.

We more precisely test this intuition using event study methodology (Campbell, Lo, and MacKinlay, 1997). Since there are no dividends in this market, the rate of return from buying a Bush contract at time t-1 and selling it the next period t is,

$$(1) \qquad R_t \equiv (price_t - price_{t-1})/(0.5(price_t + price_{t-1}))$$

where $price_t$ is the price of the Bush contract.[6] An advantage of using rates of return is that they are comparable for all price levels. The cumulative return at time t of an investment made at time t_{min} is,

$$(2) \qquad CR_t \equiv \sum_{s \geq tmin} R_s$$

The model in Appendix A shows that under some plausible assumptions CR_t is normally distributed with a variance $\sigma^2(t-t_{min}+1)^{-1}$, where σ^2 is the variance of R_t. This framework allows us to test whether the attacks had a statistically significant effect on prices at any moment. The attack has a significant effect at time t if zero lies outside the two standard error confidence interval around CR_t.

Figure 3 shows the cumulative return for the two attacks. A time period is defined as a minute, and time is normalized so the attack begins at t=0. The cumulative returns are calculated starting five minutes before the attack (t=-5), which allows for the possibility that the attacks were anticipated. The variance σ^2 is calculated from the rates of return from the hour before t=-5.[7] The bottom part of Figure 3 shows the cumulative return for the 10/15 attack. CR_t is large and negative in the two minutes when the attack was executed. However CR_t is statistically indistinguishable from zero starting five minutes after the attack began or three minutes after the attack ended. For the 9/13 attack, the return remains negative and significant for a longer period of about forty-five minutes after the attack ends (t=14).

Two alternative formulations are considered (the specific numbers are omitted in the interest of brevity). First, we calculate the mean CR_t over the two attacks. This return is no longer statistically significant twenty-five minutes after the start of the attacks or about ten minutes after both attacks end. Second, we allow for a normal level of return.

[6]Using mean price in the denominator ensures that the return from a price jump will be comparable to the return if prices then revert to their initial level.

[7]This time period is referred to as the estimation window and is supposed to reflect the normal level of price volatility in the absence of unusual events. Our results are robust to alternative estimation windows.

The adjusted "cumulative abnormal return" is calculated using two definitions of normal return: the mean return over the three days prior to the manipulation and the mean return over the prior hour. The cumulative values are quite similar those reported in Figure 3.

It is also possible to evaluate whether the attacks influenced the long-run price dynamics. In omitted results, we estimate Chow tests of the form:

$$(3) \qquad R_t = \alpha_1 + \beta_1 \times t + \alpha_2 \times I(\text{Post-attack})_t + \beta_2 \times t \times I(\text{Post-attack})_t + \varepsilon_t$$

where $I(\text{Post-attack})_t$ is an indicator for whether this time occurs after a attack. Using data from the entire forty two day observation period, we cannot reject H_0: $\alpha_2, \beta_2 = 0$ for either of the attacks. This suggests that neither set of trades had a permanent effect on the rates of return.

In total these calculations confirm the visual inspection of the time series graphs. While the attacks involved extremely high volume and initially moved prices, the prices quickly returned to their prior level and were not financially profitable for the trader. This is consistent with the argument that attacks did not alter the price dynamics for this market.

Yet it is not possible to claim these attacks were failures. The speculative attacks could be considered successful from the perspective of gaining media attention. The second attack received widespread coverage in the press and involved an investment of only twenty-thousand dollars. In contrast, a full page advertisement in the *Wall Street Journal* (one of the papers covering the attack) would have cost two-hundred thousand dollars. If the motivation was a desire to shape press coverage and perhaps generate momentum for a candidate, then the attack was a success.

III. The New York Betting Market, 1880-1944

a. Context

A second arena where we can explore the potential impact of manipulation is the large market for election betting centered in New York City between 1880 and 1944 (Rhode and Strumpf, 2004).[8] Participants could wager not only on national races but also

[8] This analysis extends the earlier literature (e.g. Williard, Guinnane, and Rosen (1996)) that uses price movements of currency and financial assets to derive market-based inferences about changes in expectations regarding political and military events. Such studies can provide valuable insights into

on state and local elections. The New York betting odds received substantial media coverage in the era before scientific polls. These historical markets are of special interest because partisans, including Democratic and Republican party operatives, actively and publicly traded. Accusations of manipulation and bluffing were rife.

The structure of these markets evolved over time.[9] Although election betting was at times illegal, it was open conducted, well publicized, and employed standardized contracts, typically involving Winner-Take-All futures. The standard practice over much of the period was for a betting commissioner to hold the stakes (or signed agreements) of both parties and charge a five percent commission on the winnings. Our information about these markets comes from articles in the major New York newspapers, which provided nearly daily quotes from early October until Election Day.

Compared with modern prediction markets, the betting volume in the historical New York market was huge. Figure 4 assembles estimates from selected newspapers of the sums wagered in the New York market from 1884 to 1928.[10] All of the dollars are converted to year 2000 purchasing power. The betting volume varied depending on whether the race was for President, Governor, or Mayor, the closeness of the contests, enthusiasm for the candidates, and the legal environment. The period of greatest sustained activity was between 1897 and 1906. But the clear peak was the 1916 Wilson-Hughes peak, when $158 million (2000 dollars) wagered in the organized New York markets. This was more than twice the total spending on the election campaigns. The betting volume tended to be much higher in Presidential years than in years when the NY Governor ran alone or the New York City Mayor was up for election. The ratios were on

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turning points in expectations and into the direction of change. Quotations about odds prices, where available, allow more direct and straightforward inferences about the levels of subjective probabilities.

[9]Moving out of pool rooms in the 1880s, activity centered on the Curb Exchange and the major Broadway hotels until the mid-1910s. In the 1920s and 1930s, specialist firms of betting commissioners, operating out of offices in the financial district, took over the trade. These firms were variously viewed as brokerages, bucket shops, or bookie joints. *New York Times*, 10 Nov. 1906, p. 1; 29 May 1924, p. 21; 4 Nov. 1924, p. 2; *Wall Street Journal*, 29 Sept. 1924, p. 13. *New York Times*, 9 Nov. 1916, p. 3. For the long tradition of election betting, see *New York Herald Tribune*, 2 Nov. 1940, p. 23.

[10] The reported totals in most instances represent the volume of money changing hands rather than the total amount staked. 1928 is taken as the end because quotations regarding volume become scarcer in the 1930s, not because activity appeared in that decade. Scattered evidence indicates volume in 1932 and 1936 was higher than at the end of the 1920s.

the order of 100:39:37.[11] That is, there was a large drop off between national and state elections, but only a small further decline for city races. The average of the median bet volumes reported in the 25 elections appearing in the figure was roughly $22 million (in 2000 purchasing power). As a point of contrast, activity on the IEM for the 1988-2000 elections has been orders of magnitude smaller, with trading volumes that never exceeded $0.15 million in any one election (see Berg, et al, 2003).

During the heyday of election betting in the late 1890s and early 1900s, the names and four-figure stakes of bettors filled the pages of New York's daily newspapers.[12] Thus, in contrast to the electronic markets of today, these activities were not anonymous. Such published stories may have served to advertise the political affiliation of the bettors as well as to confirm the existence of the wagers.[13] Among the several hundred names periodically appearing in the newspaper betting stories was a substantial number of New York's financial elite, including members of New York Stock Exchange. The current or future owners of NYSE seats include Jules Bache; Edward Bell; L. L. Benedict; Jno. S. N. Crane; Charles De Witt; Henry J. Dittman; Jacob Field; F. T. Bontecon; Eustace de Cordova; Austin J. Feuchtwanger (of Feuchtwanger & Co.); H. P. Fronthingham; Edward Jewett; George Lancon; J. M. Leopold; Charles H. Marshall; Maurice B. Mendham; Charles C. Minzesheimer; William B. Niven; Daniel O'Dell; George B. Salisbury; F. L. Seligsberg; John M. Shaw; P. N. Sproule; Henry S. Sternberger; E. B. Talcott; F. B.

[11] It was estimated that in Presidential years, about two-thirds of the bets were placed on the Presidential races and the remainder on Governor and local races. *New York Times*, 3 Nov. 1924 p. 2. Election betting markets existed across the nation over most of this period, but New York City was the center of activity until the Second World War.

[12] By way of contrast, most of the reported wagering in the 1930s involved six-figure amounts advanced by unnamed leaders in the business or entertainment worlds. This shift to increasing anonymity reflects changes in tax laws, New York state anti-gambling legislation, and the public attitudes of the organized financial markets. After passage of the Hart-Agnew Act in 1908, the Stock Exchanges periodically enacted regulations to limit involvement of their members in election betting. In 1912, the New York Curb Association publicly reminded its members that placing bets was contrary to New York laws. "Any member found betting, placing bets, or reporting alleged bets to the press will be charged with action detrimental to the interest of the association, which may lead to his suspension." *Wall Street Journal*, 8 June 1912, p. 5. In May 1924, both the New York Stock Exchange and the Curb Market passed resolutions barring their members from engaging election gambling. Again in late 1927, both exchanges blocked the use of "when issued" contracts to discourage gambling. *Wall Street Journal*, 23 Dec. 1927, p. 11

[13] Politicians as a matter of loyalty could be expected to bet publicly for their party's candidate, even when they did not favor them. For example, in 1900, Richard Croker made highly publicized bets in favor of William Jennings Bryan against his own preferences. *New York Times*, 5 Nov 1916.

Tilghman; Louis Wormser, Jr.; and Daniel T. Worden. The underlined names were major players in the New York betting markets.[14]

But it would be wrong to create the impression that the Wall Street betting markets was the preserve of NYSE members. The centers of election betting activity were on the Curb on Broad Street and in the uptown hotels, the Hoffman House, Metropole, and the Fifth Avenue. The big-money betting commissioners such as Frederick Brooks, "Eddie" Burke, John W. Cavanagh, John Considine, Percy Guard, Orlando Jones, J. J. Judge, "Sol" Lichtenstein, George A. Malarky, E. E. Smathers, Joe Ullman, "Circular Joe" Vendig, and George Wheelock were never, to our knowledge, under consideration for NYSE membership. Rather they were pool hall owners, members of the Metropolitan Turf Association (the NYC "bookmakers' club") or brokers on the Consolidated or Curb Exchanges.[15] The newspapers also highlighted the activities of political stalwarts such as Henry C. Swords and future NY Governor, Benjamin B. O'Dell, Jr., as well as many of the leading Tammany tigers-- Richard Croker, Timothy D. Sullivan, Patrick H. McCarren—among other.[16] Tammany Hall, the NYC Democratic machine, was reputed to have a special war chest to finance its wagering.

We can gain a much fuller picture of the participants in these turn-of-the-century betting markets by matching the persons mentioned in the newspapers with Population Census and other genealogical records. This task is made vastly easier by the availability of *ancestry.com*. In our preliminary matching exercise, 72 bettors mentioned in the *Wall Street Journal*, *New York Herald*, *New York Sun*, *New York Times*, *New York Tribune*, or *New York World* --there is great commonality in reporting across these papers-- were matched to the Census of Population for 1900.[17] Figure 5 compares the occupational

[14] We thank Petra Moser for making her membership records for the NYSE available to us. Newspapers also make frequent reference to anonymous "Stock Exchange members."
[15] The stock brokers were generally Republicans and the book makers Democrats (cite quotes from 1890s).
[16] Regarding the participation of politicians, see *New York Tribune*, 2 Oct. 1884, p. 4; 16 Oct. 1888, p. 2; 9 Nov. 1894, p. 3; 5 Aug 1896, p. 1; 31 27 Oct. 1896, p. 5; 24 Oct. 1897, p. 6; 5 Sept 1900, p. 14; 18 Sept 1900, p. 2; 30 Sept. 1900, p. 5, 12 Oct 1900 p. 3; 20 Oct 1900, p. 3; 8 Nov 1904, p.1; *New York Herald Tribune*, 6 Nov. 1928, p. 3; *New York Times*, 27 Oct. 1896, p. 3; 30 Oct. 1896, p. 1; 1 Nov 1896, p. 8; 8 Nov. 1900, p.5, 23 July 1936, p. 8; 24 July 1936, p. 8; 25 July 1936, p. 6; 29 July 1936, p. 6; 9 Aug. 1936, p. 29; *Wall Street Journal*, 31 Oct 1916, p. 8; 27 Oct 1920, p. 1; 29 July 1936, p. 1.
[17] We make no claim that our preliminary list of matched bettors represents a random sample of the names appearing in the newspaper betting stories over the 1897-1906 period. Definitively linking persons with common names proved difficult in a city as large as New York. And in some cases, the published names appear to be "betting handles" used by no one reporting to the Census in 1900. In others (e.g. Richard

distribution of the matched sample with the city of New York at this year. (All of the listed bettors were males; to improve comparability the general occupational distribution is for males only as well.) The differences are stark. Whereas 0.6 percent of the male labor force in New York City was a "banker or broker" in 1900, 44 percent of the matched bettors belonged to this category.[18] "Government officials" comprised 0.4 percent of the city's labor force but 5.6 percent of the bettors; hotel keepers made up 0.3 percent of the labor force but 4.2 percent of the bettors. Even the "other" category hides further great differences. Not one of the matched election bettors performed the type of blue-collar job in manufacturing, transportation, or domestic servant that occupied the vast majority of the 1.1 million males workers in New York City. Indeed, the stakes reported in the press were well in excess of the average earnings of the typical wage-earner in New York during this period.[19] In summary, the participants listed in the newspaper stories were a highly unrepresentative sample of the population (or electorate) and included persons of varied backgrounds whose living depended on taking well-reasoned but large gambles on political and financial outcomes.[20]

The public wagering of large sums by prominent individuals is all the more noteworthy because organized election betting was of questionable legality. Under New York state laws, it was legal for private individuals to make casual election wagers (although it disqualified one from voting and the contracts were not strictly enforceable in court). Formal organized gambling was a different matter. In the aftermath of the

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Croker), the participant was out of the country at the time of enumeration. A search of the 1880 and 1910 censuses located some persons missing from the 1900 tally. Newspaper coverage—some names are listed many, many times whereas other bettors go nameless—also raises issues regarding how representative our sample is of the typical participant. Nonetheless, we are confidence that the differences between the characteristics of our matched sample and the general NYC population are not solely or even chiefly due to biases in our matching strategy.

[18] U.S. Bureau of the Census (1904), 456-59.

[19] Even for those who could not afford to bet such stakes, election betting was a cherished ritual. In this era, it was widely asserted that one should be prepared to "back one's beliefs." *New York World* 14 Nov. 1876 p. 4. Making freak bets – where the losing bettor literally ate crow, pushed the winner around in a wheelbarrow, or engaged in similar public displays– was highly popular. Gilliams (1901) p. 186 stated as "a moderate estimate" in the 1900 election "there were fully a half-million such bets—about one for every thirty voters." During this period, election nights were social events comparable to New Year's Eve or major football games. In large cities, crowds filled restaurants, hotels, and sidewalks in downtown areas where the leading newspapers would flash signals by searchlights to relay the latest returns and interested parties would wager on the coming news. For weeks after Election Day, newspapers would run stories of unfortunate losers performing ridiculous stunts to meet their election wagers.

[20] The mean year of birth of the 64 matched bettors was 1859.12 and the standard derivation was 12.98. The median was 1859 and the mode, 1876.

cancellation of the 1876 election pools, the New York legislature outlawed pool-selling. Under the Hart-Agnew Act of 1908, professional bookmaking employing written bets became illegal (and a 1910 extension covered oral bets). The prohibition was directed primarily against gambling on horse races, but also worked to reduce betting on the elections immediately following its passage.[21] When the heat came off after a few years, election betting revived. Ironically, in the 1916 contest between President Wilson and Charles Hughes, who as New York Governor had signed the Hart-Agnew act into law, election betting on Wall Street reached its peak.

As the center of national wagering, the Wall Street betting markets were widely recognized for their remarkable ability to predict election outcomes. The *New York Times* put it, the "old axiom in the financial district [is] that Wall Street betting odds are 'never wrong'."[22] As noted in our earlier paper, the contemporary press noted that the Wall Street betting favorite for President almost always won, with the only exception being the extremely close 1916 contest. The ability of the betting market to aggregate information is all the more remarkable given the absence of scientific polls before the mid-1930s. The *Wall Street Journal* contended that the accuracy of betting odds held not only for "national elections but applies equally to state and local races."[23] The odds were "generally considered the *best forecasters* of Presidential elections (emphasis ours)," as well as "good indicators of probable results in gubernatorial and Mayoralty results."[24]

Contrary to these assessments were the frequent assertions that active partisan involvement, especially by Tammany Hall, systematically distorted the betting odds and, at times, speculative attacks attempted to change the momentum of the races and influence voter turnout. As one example, in closing days of 1926 race for the NY Governor, the campaign of Republican Ogden Mills vocally charged that Al Smith's

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[21] The betting commissioners in the financial district initially responded by revising their contract form – creating a memorandum between "friends" to transfer money conditional on the election outcome—and by raising the commission rates to reflect their increased legal exposure. And there was some talk of moving operations to New Jersey and many commissioners reduced or stopped keeping book. *New York Tribune*, 30 Oct. 1908, p. 1. See also *New York Times*, 22 Oct. 1909, p. 1; 11 July 1912, p. 10; 18 July 1912, p. 1. Regarding changes in commission rates, see the *New York Tribune*, 30 Oct 1908 p. 1

[22] *New York Times*, 28 Sept 1924, p. E1. See also 30 Oct. 1916, p. 4; 7 Nov 1916, p. 1; 7 Oct 1924, p. 18; 6 Nov 1928, p. 46, 8 Nov. 1932 p. 33; 2 Nov. 1936, p. 20.

[23] *Wall Street Journal*, 27 July 1920, p. 11.

[24] *Wall Street Journal*, 17 Aug. 1925, p. 5. See also 27 July 1920, p. 11; 29 Sept. 1924, p. 13. The 1925 article added the betting odds were less accurate guide for offices below Mayor because less attention was devoted to studies the contests for minor offices and little money was wagered,

backers were resorting to the old Tammany trick of using election wagers as "indirect propaganda."[25] But Tammany was not alone in possessing a betting war chest. Republicans, especially those on Wall Street, purportedly organized funds to finance speculative attacks. As another example, the *New York Times* on 28 Oct. 1904 charged the GOP of manipulating the betting odds in favor of T. Roosevelt in the Presidential race. The historical record is rife with such charges, most levied against partisans supporting the favorite. As an example, in 1916, Democrats charged "the money was being sent to Wall Street to force the betting odds to Wilson's disadvantage, for the effect of wider odds would have, especially on up-State farmers, who in the past have been influenced by wagers reported here from below Fulton street. 'Already,' one prominent Democrat said, 'we are hearing that many up-State farmers are struggling between their conscience and fear that Hughes will be elected and it might be found out that they voted for Wilson."[26]

b. Our Data and Their Implications

To analyze how manipulation affected the information-aggregation properties of the New York betting markets, we have collected a large dataset of betting odds on the presidential, gubernatorial, and mayoral races over the 1880s to the 1940s. Our sample is drawn from the *Brooklyn Eagle*, *Chicago Tribune*, *Christian Science Monitor*, *Los Angeles Times*, *New York American*, *New York Daily News, New York Evening Journal*, *New York Herald*, *New York Sun*, *New York Times*, *New York Tribune*, *New York World*, *St. Louis Post Dispatch*, *Wall Street Journal*, and the *Washington Post*. Our sample currently includes 3701 daily odds prices for 142 candidate-race-year triplets (that is, a given candidate running for a given office in a given year). The unit of observation is one daily odds price from each newspaper article.[27] The sample covers 16 Presidential

[25] *New York Times*, 17 Oct. 1926, p. XX10.
[26] *Washington Post* 5 Nov. 1916 p. 1.
[27] That is, we may have several different observations on a candidate's odds price on a given day from different newspapers (or much more rarely, from different articles in the same paper.) If a single article reports several wagers, we average to derive that day's single observation. We have made no attempt to eliminate duplication resulting from multiple publications of the same article in different newspapers, as might happen if a wire service ran a story on the state of NY betting markets. We have been careful, however, to date the odds price to the day the betting took place rather than the day of the article and to focus on actual bets rather than mere offers.

elections (1880-1944); 22 Gubernatorial elections (which basically occur biennially from 1888 to 1936), and 14 Mayoral races (1890-1937). Where possible, we have also tabulated bets on the outcome of the presidential races in New York State. Appendix C briefly surveys the NY mayoral and gubernatorial elections from 1890 to 1937.

Figure 6(a) indicates the odds prices do possess considerable predictive power. The graph shows the popular vote margin received by each of the 142 candidates against the odds prices in the 90 days before the election. (For a theoretical justification of this relationship between the odds price and the vote share, see Appendix A and specifically, equation A5.) There are multiple observations for candidates because the odds prices are drawn from stories in many newspapers over many days during the campaign. The odds presaged the election outcomes in the vast majority of cases. Ignoring even-money bets for a moment, 58.5 percent of the quotes were in the northeast quadrant (favorite and popular vote winner), 13.0 percent in the southeast (favorite and loser), 7.7 percent in the northwest (underdog and winner) and 20.8 percent in the southwest (underdog and loser).[28] By this crude measure, almost four-fifths of the quotes the market correctly categorized the candidate.

The regression results reported in Table 2 provide further evidence that the odds prices were informative. Adding the log of the odds price in logistic regressions of the candidates' outcomes in presidential, gubernatorial, and mayoral races substantially increases the explanatory power beyond simply including *ex ante* observable variables such as the candidate's party and incumbent status. (In these regressions, incumbent status is coded as 1 if the candidate is the incumbent for the office, -1 if he is challenging the incumbent, and 0 if there is no incumbent in the race.) While informative, the odds prices do not prove to be sufficient statistics. Under an efficient markets assumption, the odds prices should capture all publicly available information, implying zero coefficients for party and incumbent status. To the contrary, these two variables remain statistically significant in all of the regressions.

Figure 6(b) pools the data on odds price across different election outcome to provide another appraisal of the forecasting accuracy. Under efficient markets, the share

[28] The exercise is partially clouded by events such as the 1888 election when Cleveland won the popular vote but Harrison won the Electoral College vote and became President.

price should represent the best guess of the candidate's probability of victory (see equation A6 for details). The figure groups the data into bins based on the odds price.[29] The bins are [0,10), [10,20), [20,30), [30,40), [40,50), [50], (50,60], (60,70], (70,80], (80,90], and (90,100]. The plotted value on the horizontal axis uses the midpoint of each bin. The vertical axis is the mean outcome (defined as one if the candidate wins and zero otherwise) of observations in the bin. To give a sense of precision, we calculate bootstrapped standard errors (bootstrapping is desirable because observations from the same election are correlated; we have N=52 elections.). The data are not wildy at variance with the efficient markets prediction that points should lie along the forty-five degree line.[30]

The main pricing anomaly highlighted in this figure is the favorite-longshot bias common in betting markets (Thaler and Ziemba, 1988).[31] Favorites win more often, and underdogs win less often, than the odds suggest. The bootstrapped standard errors show that the difference from the predicted forty-five degree line is statistically significant. In fact any bet made at an odds price above 70 was virtually certain to win and any bet made below 30 was virtually certain to lose.

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[29] This approach treats each newspaper story as a separate observation. Using daily odds (averaged across the newspapers) yields qualitatively similar findings. The inversion around even odds is slightly muted in the daily average data compared with the disaggregated sample. The betting volume estimates, reported in Figure 4, are more highly correlated with the number of individual stories (correl. coeff. = 0.70, N=28) than with the number of days in which stories appear (0.54). We take this as justification for treating each story as the unit of observation and further note using daily data likely will not change the results presented. Two side notes: (1) in the sample years, the correlation between numbers of stories and days is 0.92; and (2) the number of stories per day tends to rise as Election Day approaches and betting accelerates.

[30] The wide confidence intervals in the middle of the figure are due in part to the limited number of elections in each bin. The election outcomes are therefore clustered which increases the bootstrapped standard errors.

[31] There is also an interesting pricing inversion in the intervals around 50 percent, where those who are slightly favored (e.g. Hughes in 1916) lose and those who are slight underdogs (Wilson) win. A potential explanation is that political parties focus their efforts at manipulating the market when their candidate is a slight underdog. The idea is that supporters of candidates are willing to "pay too much" to attain the status of front-runner in a close race as well as to make someone with little or no chance appear viable. It is easy to see the enormous payoff in an election of pushing one's vote share from 49 percent to 51 percent, it is more difficult to understand the value of raising one's chance of winning from 49 to 51 percent (as opposed to raising it from 54 to 56 percent). It appears being the narrow front-runner is associated with reduced chances of success. Still the race for NY Mayor, where one would expect Tammany influence was greatest, is the one contest without this inversion (results omitted).

Still we do not want to emphasize this point, since the inversion is not statistically significant. That is, it is not possible to reject a hypothesis that the fitted probability of winning is the same for the [40,50) and (50,60] bins.

An alternative way to investigate the favorite-longshot bias and related issues is to evaluate the *ex post* profitability of employing selected betting strategies. These include either (a) buying contract at the odds prices or (b) betting a dollar on the favorite at every observation in our sample in the 90 days before the election. Note that strategy (a) more closely mirrors the market whereas strategy (b) involves greater risks as one is investing relatively more in long-shots. These results are reported in Table 3. The average *ex post* payoffs were positive and large in the races for Governor and, especially, for Mayor, even after subtracting a five percent commission on winnings. The standard errors on individual bets were large and the possibilities for diversifying these risks in a given race were obviously limited. But the impression that the market undervalued the favorite stands. This is pertinent because the historical record suggests manipulations typically involved over-valuing favorites.

c. Studying Charges of Manipulation

We investigate whether purported speculative attacks, or more correctly episodes associated public charges of manipulations, induced long-lasting prices movements unwarranted by the fundamentals. Given the available information about the activities of the market agents, we can not state whether intentional manipulation actually occurred, only what happened during an episode in which manipulation was publicly charged in one of the major newpapers. In this historical investigation, we are in the same position as being outside observers as in the 2004 *TradeSport*s episodes. One difference is that we are sure in the historical markets that partisans were actively involved.

To identify the relevant events, we have surveyed the leading New York daily newspapers (with special emphasis on the *Times*) and classified the "manipulation" stories into three categories: (a) charges of intentional manipulation with investors betting to drive odds prices away from the levels justified by fundamentals; (b) charges of wash bets, that is, of bets made between confederates at non-market odds for publicity purposes; and (c) charges of bluffs, that is, offers to make bets at non-market odds which are withdrawn when the offer is accepted. In this exercise, we have employed both computer keywords searches using Proquest.com and extensive reviews of thousands of printed newspaper stories by the authors. We do record the direction of the

"manipulation" (i.e. in favor of the Republican's or Democrat's odds) but not the sources of the activities or of the charges. In 1916, for example, stories circulated charging a politically unaffiliated financial agent of manipulating the Presidential odds for purposes of influencing asset prices. Charges were advanced by participants in the betting markets, those in related financial markets, by newspaper writers, as well as the supporters of the electoral campaigns involved.

One might think that all such charges were "cheap talk" and that they would be as ubiquitous as stories of partisan involvement or stories of voting fraud. But there were not. Charges of intentional manipulation occur on only about 2 percent of days with reported betting odds. One reason that charges were not made more frequently is that the election cycles represented repeated games and the making unsubstantiated charges of manipulation would aversely affect one's reputation and the creditability of one's future charges.

Our investigation finds there were 46 charges of manipulation/wash sale/bluffing events during our sample period. Of these alleged events, 11 charges involved full-blown manipulation of the odds in favor of the Democrats and 8 manipulations in favor of the GOP. 11 of these alleged attacks involved presidential races; 8 state and local races. The mean event occurred 7.8 days before the election and the median 4 days before election day, that is, during the last weekend of the campaign. There were 5 of wash sales and bluffs in favor of the GOP and 22 in favor of the Democrats. (Of these minor charges regarding the Democrat odds, almost all were bluff betting, the so-called "Old Tammany Trick.") Most of the alleged events occurred in the month before Election Day--the mean was about 8.9 days before voting began. One accusation was 103 days before Election Day; the median event was 5 days, that is, in the final week of the campaign. The average odds price on the candidate subject to positive manipulation were marginally above even odds.

Given the nature of the historical data, we must make several adjustments to the event-study methodology employed above. First, our historical observations are of lower (at best daily) frequency but from multiple sources. Our data will be the daily odds prices quoted in the available newspapers. Second, the alleged historical manipulations do not all occur for a single candidate nor do they all push in the same direction. Our

approach will to investigate the separate effects of the Republican and Democratic "attacks" on the "Democrat's price." Given data availability and a desire to avoid duplication, we will use the price quotes for the favored candidate in each race. Where the favorite is the Democrat, their prices will be used directly; where the favorite is not the Democrat, we will define the "Democrat's price" as one minus the favorite's price. (Only in the 1924 race does this procedure create any problems.) Third, to control for differences across the races, we include election-specific dummy variables. Fourth, given that many of the events occur close to the election (often the weekend before), we will define the window as extending 5 days after the alleged manipulation. We will begin the window one week before. (We treat new manipulations occurring within the window as separate events.)

One further note about timing: A purported attack is typically dated to occur one day before the newspaper allegation is published. This places it in line with the odds published on that day. As will become apparent, the price moves associated with an allegation may precede publication by more than one day. We cannot rule out the possibility that a genuine information shock drove the price movements. It is important to note, however, that the story containing the allegations was written before the prices of the current day were revealed.

Our analysis examines these effects for the Presidential race and for all races combined. Table 4 reports the regression results measuring the impacts of manipulations and wash sales/bluffs on the "Democrat" odds price. The wash sales and bluffs prove to have little or no meaningful effect on prices, consistent with interpreting such charges as "cheap talk." As a consequence, we will focus on the impact of manipulation events. These impacts may be more easily visualized by examining Figure 7, which shows the movements in the "Democrat" odds prices as well as the error bounds.

Figure 7 (a) shows estimates for manipulation in the Presidential election market. The effects associated with a charge of a "Republican attack" on the President market may be described as follows. The Democrat price over the week before the attack was trending down. In the day of the event, the price fell 0.02. Over the next day, prices reverted back into the range prevailing in the previous week. The effects associated with a charge of "Democrat attack" in the Presidential market were somewhat different.

Prices were far more volatile in the period before the charges. Over the day of the alleged attack and the next day, prices jumped about 0.12. But they fall back down sharply on day two and then trend into the range prevailing over the week before the attack.

Figure 7(b) examines attacks in all races. Combining the races increases the sample, especially of Democratic manipulations. The pattern for Republican attacks in all races is similar to that in Presidential races. Prices were low but stable up until the day before the charge, then jump down on the day of the "attack" before bouncing right back up. The pattern for Democrat attacks is smoother than for the Presidential races alone. There is a more moderate rise from the day of "attack" through day 3. Prices begin to trend down in days 4 and 5 but remain above the range prevailing during the week before. This suggests manipulation in local races had greater long term effects.

Figure 7(c) shows the price effects of manipulations on the Democrat odds prices where Democrat and Republican manipulations are both included (the Republican manipulations are coded as inverses of the democratic manipulations). The regression results for the presidential races are sharper than those above (these estimates are omitted). The day of the manipulation witnesses nearly a 0.035 jump up in the Democrat odds prices. But prices quickly revert and by day two are within the range of the pre-manipulation period. Prices then begin to rise again. For all races, the manipulations were associated with a much smaller increase, less than 0.02. Prices drift down by the days two and three before again beginning to rise. Nothing in these patterns suggests that manipulation events led to large, irreversible changes in prices.

As a summary, our analysis of the historical record indicates that: (1) A large political betting market could operate despite (or perhaps because of) the active participation of partisans. The market betting odds possessed considerable predictive power; (2) these prediction markets were not fully efficient-- a long-shot bias was evident; and finally (3) events tied to public charges of manipulations were not associated with large unwarranted changes in the odds prices.

Our analysis of manipulation in the *TradeSports* futures and the historical New York betting markets is limited because we are in the position of outside observers. We do not know the motivations of the investors who are affecting the price shifts. A field

experiment conducting in the Iowa Electronic Market (IEM) in 2000, however, offers us the unique perspective of being insiders with knowledge about the timing and magnitude of a series of trades being made for reasons unrelated to changes in the fundamentals.

IV. Iowa Electronic Market (IEM): Field Experiment

a. Background

The IEM is a real-money, online futures market operated by the Henry B. Tippie College at the University of Iowa (http://www.biz.uiowa.edu/iem). It is currently the sole legal site in the US to trade in political information futures. Its operations differ from either *TradeSports* or the New York betting markets because participants are limited to relatively modest stakes ($5 to $500). The IEM's clientele tends to be a select group: highly educated, young, predominately male, employed with academic or research job (Oliven and Rietz, 2004). Despite these constraints, the IEM political stock markets have performed quite well. They typically forecast better than polls, and they pass many tests of market efficiency (Berg, Nelson, and Rietz, 2003).

In this paper we focus on the IEM markets on the 2000 presidential election. These markets had $167,000 in trading volume and had about one thousand active investors. In the IEM presidential markets, there were two forms of contracts: Winner-Take-All (WTA) and vote share (VS) contracts. Both assets were available for the Democratic candidate (DEM), the Republican (GOP), and the Reform party (REF). The VS contract was akin to a point-spread wager in sports betting and paid conditional on the size of the candidate's plurality of the vote. The IEM WTA contract was like a win-loss contract in sports betting but with one important difference. It paid off for the candidate who received the largest absolute vote, not the candidate who as actually elected president.

This created much confusion on election night 2000 when the popular vote went for Gore but the Electoral College vote was projected for Bush. Figure 8 charts the gyrations of the IEM WTA contract on the night of 7 Nov. 2000 and morning of 8 Nov. According to the IEM definitions, Gore won the 2000 contest for both the VS and WTA contracts. Yet when the major networks proclaimed that Bush had won the Electoral College at 1:20AM CST, the price of his shares rose to near a dollar. At this point it was

already apparent that Bush was going to lose the popular vote (he was slightly behind in the VS market at midnight of 11/8), and he fell behind in the official aggregate vote tallies between 3:30 and 4:20AM CST. At this point, there was little uncertainty with regard to the IEM contracts and yet the prices were the exact opposite of where they should be. This is consistent with traders incorrectly believing the WTA contract was based on the Electoral College. The market slowly reversed itself and (the day after the election) the correct price was offered.

The definition of the IEM WTA contract differs from the analogous contracts prevailing in the historical markets and in the *TradeSports* 2004 presidential futures markets, both of which were linked to the Electoral College winner. The IEM markets have the useful analytical feature that both the VS and WTA prices are linked directly to the same fundamental variable, the final vote share. As we describe below, this implies there exists an equilibrium relationship between the prices under efficient markets and that one price may serve as a control for the other.

b. Experiment

During the summer and fall 2000, one of the authors engaged in a series of controlled uninformative trades in the IEM presidential markets. The trades sought to mimic the behavior of an insider with private information and followed a formalized protocol.[32] The trades involved randomly investing real money in one or both of the WTA and VS contracts, with the side -- DEM or GOP --determined based on hundredth digit of Dow day before. Our goal was to test whether other investors recognized these were uninformed speculative attacks (sending prices back to their initial level), or rather they believed they were due to news shocks (and so prices did not revert).

There were 11 planned trades, roughly 10 days apart, starting 110 days before the election. The trades were typically executed in 15-30 minutes in a trading window time starting at either 8 pm or 11:15pm CST. The late evening schedule was selected to increase the chance that the trades shift beliefs and lead a long-term change in prices. The first reason for this is that information was less widely distributed during these times

[32]The procedures are codified in official trade strategy document, *iowa.strategy.2b.doc*, which is available on the author's web page. There was also an outside board which received this document prior to the execution of any trades.

than earlier in the day. It would be difficult for an investor to refute that a price change was due to a news shock, which at these hours might not be widely reported and known only by the individual making the trades. A second reason is that late in the day volume is relatively light, and few traders are likely to be actively monitoring the market. Prices may stay distorted until the next morning when more traders come online. Thus the experimental design leans towards finding evidence of manipulation.

The experiment was designed to exploit the existence of the two IEM presidential markets. Some investments were in one market only and others were in the two simultaneously. The idea was that a trader with fresh inside information would likely invest in both markets whereas, perhaps, a non-financially motivated trader might invest just in one.[33] The two markets also help us distinguish between three leading hypotheses about the market response: (i) the markets are not actively monitored; (ii) the attacks change beliefs and markets are monitored; (iii) the attacks do not change beliefs and markets are monitored. The second hypothesis indicates successful manipulations are possible and likely indicate that investors believe that there has been a change in fundamentals.[34] The last hypothesis suggests it is difficult to successfully manipulate these markets.

Table 5 summarizes the predictions of the three hypotheses. The first row indicates that price movements allow us to distinguish between the hypotheses using simply a one-market attack. Since the VS and WTA markets are linked to the same fundamental (final vote shares), under efficient markets there should be an equilibrium relationship between the markets. Appendix Section A shows this relationship is,

$$(4) \qquad \text{price}^{WTA}{}_t^* = \sigma_{vt}^{-1} \times \text{price}^{VS}{}_t^*$$

[33]The one exception is an event which creates greater uncertainty but does not favor one candidate or the other. In this case the price of the favorite should decline in the WTA market but not the VS (see the model in the Appendices).

[34]It is also possible that investors believe that other participants will change their behavior. For example, there may be a "Soros effect" where investors believe the trades were made by a single speculator who will continue to invest and himself sustain a price change. But this is not likely in the IEM, since there is a $500 limits on investments.

where "*" indicates an inverse normal transformation and is σ_{vt} is a measure of uncertainty t periods before the election.[35] If the attacks alter market beliefs, than when only one market is attacked prices in the unaltered market (the control market) should also move. If beliefs are altered (or if markets not monitored) than the control market should be unaffected. The second row summarizes the predictions for a two-market attack. While this case does not provide a clean test, it is still interesting since as we mentioned it may more realistically depict the investment of an insider with private information.

Table 6 shows that the dates of the trades and the details of each investment. The experimental design involved three types of trades: investing in the WTA contract alone; the VS contact alone; and in both the WTA and VS contracts. The investments were made as follows. For WTA contracts, if it was randomly determined (by the Dow) to buy GOP, then an initial investment of $160 was used to purchase this contract at market prices. (The strategy also allowed the alternative of buying the entire slate and shorting DEM if that was cheaper.) Following these trades supporting limit orders were placed for $80 to buy GOP at $.006 below last Ask and $80 to sell DEM at $.006 above last Bid. (These expired untraded in some cases.) If the trade involved a VS contract, the procedure was identical but for one-half the amount. The 10/28 trade was different in that all of our holdings were sold that day ($566 in total).

Given the nature of the IEM, the size of these investments was large relative to total trade volume. The third to fifth columns of Table 5 list the dollar amount of each trade. An aggregate sum of $3116 was wagered, which was about two percent of total IEM trade volume. The largest trade of a VS contract was 3.0 percent of the current market cap (listed in column 6) while that of the WTA contract was 2.7 percent. Note that the relative size of fixed-sum trades declined over time as the market expanded. The individual trades were large relative to daily trading volume. A typical trade represented

[35]Under a simplifying presumption in the law of motion of news shocks, $\sigma_{vt}=(t-T)^{0.5}$, where T is the period with the election Using daily closing price data from the 2000 IEM, we estimate the following relationships,

Democrats (R^2=0.74): $price^{WTA}{}_t^* = -0.012 + 40.188 \times price^{VS}{}_t^* \times (T-t)^{-0.5}$

Republicans (R^2=0.71): $price^{WTA}{}_t^* = 0.018 + 38.910 \times price^{VS}{}_t^* \times (T-t)^{-0.5}$.

Consistent with the theory the constants are not statistically significant. We also estimated analogous equations relating the VS price to the WTA price.

181 percent (=$120/$66) of average daily volume in the VS market and 28 percent (=$240/$870) in the WTA market.

The initial price changes after the trades were generally large, comparable to daily range of trading. The specific values, right before and right after the trades, are listed in the last three columns of Table 5. To provide perspective, the average *intraday* price range was 0.5¢ for the VS contracts and 3.8¢ for WTA and the average price range in hour before trades were about 0¢ for VS contracts and 0.5¢ for the WTA. The price changes 30 minutes after the controlled trades were 0.3¢ for the VS and 2.5¢ for the WTA. That is, the changes were much larger than in the prior hour and roughly sixty percent of the intraday range. As an example, Figure 9 illustrates the time path of prices following the 10/28 trades.

The data for our analysis was collected from trader accounts, which provide basic statistics on each asset at any time: last, bid, ask, high, low. The main IEM web page updated the information every 15 minutes while the trader screen was updated in real-time. We collected data from the trader screen for several hours before, during, and after the trades. Joyce Berg has kindly shared with us additional IEM price data to supplement this investigation.

c. Results

We aggregate the data from our eleven trades into fifteen-minute periods (the frequency at which the price screen is refreshed on the main IEM page). For prices we use the last traded price, and if there are multiple observations in the period we average these prices. When the attack called for shares to be sold, we take the negative of prices. This ensures the attacks are aligned, with each case seeking to increase prices.

For each trade we calculate the cumulative returns (CR) using the formula in equation (2), and start the calculation six periods (an hour and a half) prior to the start of each trade. We will focus on average CR's for various subsets of trades. To establish confidence intervals we calculate the volatility of prices prior to each trade. In particular we calculate a CR starting roughly a day before each trade and take the mean standard deviation across these CR's. Since Appendix A shows the mean CR's are normally distributed, the two standard deviation interval is roughly a ninety-five confidence band.

We begin the analysis by focusing on the markets that are attacked (rather than the control market). Figure 10 shows the average CR for the full set of eleven trades. The figure plots CR values and their associated confidence intervals for the first five hours after the trades. There is little trend in the return prior to the attack (t=0), which suggests the trades were not reinforcing some pre-existing price trend. The CR increases by a statistically significant four percent in the first half hour (the typical time to fully execute a trade), reflecting the large change in prices associated with attacks. The CR begins to decline immediately following the end of the trade period, and half of the effect is undone within two hours (and the effect is no longer statistically different from zero). The CR returns to zero within twelve hours. The relatively rapid unwinding of the attacks is impressive given that they occur during low volume periods, as discussed earlier

Continuing to focus on the attacked market, we next consider various subsets of attacks. Figure 11 shows the average CR for the four WTA-only and three VS-only attacks. In the WTA trades the returns spike up even more sharply following the attack, with a seven percent return in the first half hour. The mean CR stays at an elevated level for the first two hours, at which point there is a large reversion. The price increase is basically fully undone within five hours. The VS trades have a rather modest effect and prices initially increase less than one percent. The mean CR remains virtually unchanged for the next nine hours, reflecting the relatively low activity in this market (see the market caps listed in Table 6), at which point prices quickly return to their initial level. We do not read too much into this slow reversion, given the small levels involved and the lack of statistical significance evident in Figure 11.

Figure 12 presents the average CR for trials in the first or second half of the observation period (because the market cap tends to increase over time, this can also be thought of as trials in a small or large cap). The early/small cap trials had a rather modest initial effect which entirely disappears within two and a half hours. Alternatively, the late/large cap trades result in a large 8 percent increase in the CR in the first half hour. There is some reversion over the next five hours, but the CR remains large (about four percent) and is statistically significant. The CR gradually falls in half over the next seven hours, and is completely undone twenty-four hours after the initial attack. This slower reversion in the later period is somewhat surprising, since the market cap is larger and

presumably there are more investors monitoring prices. Given the confusion on election eve, perhaps the late arriving investors are less experienced and perhaps more susceptible to being fooled by these large trades.

Figure 13 shows two more sets of trials in which the CR slowly reverts to zero. When both markets are attacked, the positive CR effect levels off at about two percent for hours one to twelve (though the wide confidence bands are a caveat). The positive effect persists for about twenty-four hours. This makes sense, since we have already argued that an insider would prefer to trade in both markets if he really knew there was a change in the fundamentals. Hence market participants would lend more credence to these trials. The CR also does not revert for about a day when the trial involves a purchase of Democrats and/or a sale of Republicans. The explanation for this case is less obvious and may reflect some partisan sentiment. It is important to stress that the reversion speed is not simply due to differences in the initial response. The mean CR increases over four percent for trials involving a single market attack or for trials with Democrat sales/Republican purchases, and yet the CR reverts much faster to zero (figures omitted).

Figure 14 presents results for the control market in single market attacks. Recall that the VS and WTA markets are based on the same fundamentals and are linked in equilibrium according to equation (4). Prices in the non-attacked control market should not move if market beliefs are unchanged. The top panel in Figure 14 is consistent with this hypothesis. While there is a small response in the half hour following the attacks in the other market, the price change is not statistically or economically significant (it increases a half percent). Moreover, the CR becomes negative (and still small) within forty-five minutes at which point we have already seem the returns are still positive in the attack market.

The bottom panel of Figure 14 provides a more direct test of the hypothesis that beliefs remain unchanged following our trades. While the previous figure considers the average response in the control market, it is more appropriate to see whether there is a greater response in trials which had a larger effect in the attack market. In particular we calculate the "abnormal return" in the control market given its equilibrium relationship to the attack market. Equation (4) provides a measure of the normal WTA price, and if it is

inverted it yields the normal VS price. These can be used to calculate the normal rate of return at time t,

$$(5) \qquad R_t^{Normal} \equiv (price^{Normal}_t - price^{Normal}_{t-1})/price^{Normal}_{t-1}$$

where $price^{Normal}_t$ is the normal price. In analogy to equation (2), the cumulative abnormal return at time t of an investment made at time t_{min} is,

$$(6) \qquad CAR_t \equiv \sum_{s \geq tmin} (R_s - R_s^{Normal})$$

The bottom if Figure 14 shows that the CAR for the control market becomes negative right after the attacks and then starts to revert to zero. This pattern is the mirror image of the CR for the attacked market in Figure 10.[36] Taken together this means that prices in the control market do not move enough to offset the price increase in the attack market (though the two markets typically move in tandem as reflected by the CAR values near zero prior to the attacks). The experience in the control markets supports the notion that investors realized that the attacks were non-informative and is consistent with the claim that the attacks did not move beliefs.

The field experiment involving the IEM 2000 election provides a unique opportunity to investigate the market responses to uninformative trading. Eleven large trades were made at times and in directions unrelated to changes in fundamentals and nine had a significant initial impact on the IEM prices. But over a short period of time, all of these attempted manipulations were largely undone by other traders In total, these results suggest that the long-term market dynamics were not influenced by uninformative trading.

V. Conclusion

The promise of improving decision-making by tapping the "Wisdom of Crowds" through the use of prediction markets has attracted great interest in recent years. An important challenge to utilizing such markets is the possibility of manipulation and speculative attacks by partisan or large moneyed interests. To assess this challenge, the paper has analyzed alleged and actual speculative attacks— large trades, uninformed by

[36]The comparison is even clearer when the attack market CR is graphed for single market attacks.

fundamentals, intended to change prices —in three markets: the 2004 *TradeSports* market for President, the historical Wall Street betting markets, and the Iowa Electronic Market in 2000. In almost every speculative attack that we study there were measurable initial changes in prices. However, these were quickly undone and prices returned close to their previous levels. Our investigation of evidence from field experiments and contemporary as well as historical observational data suggests it is difficult and expensive to manipulate political stock markets beyond short periods. And the period appears to become shorter over time—from days (New York Markets) to hours (IEM) to minutes (*TradeSports*).

Among the questions for future research are: do these results hold for other prediction markets? What are the key characteristics that ensure markets are not easily manipulated? We have shown that certain characteristics are not crucial, because there is variation across the markets we study. For example, having public or anonymous markets does not seem to matter. But there are other traits that are common to all of our markets: large and thick market; small number of possible outcomes; and presence of diversity of opinions. In identifying which are the essential characteristics we might gain a better understanding of why certain of these markets work so well at making accurate predictions.

Appendices

Section A: A Framework for Political Stock Markets

Winner-Take-All Market

The efficient markets test can be applied to time series data, e.g. daily contracts for the winner of the overall election. The key feature of such data is that the uncertainty should systematically decrease as we approach the election date. We present a model related to the analysis of futures markets in Samuelson (1965).

Suppose that time is discrete and in each period some news about the candidates arrives. For concreteness we focus on the Democrat's electoral prospects, and presume there is a latent level of Democrat support (two party vote share) each period. The Democrat's latent support evolves according to,

(A1) $\text{VoteShare}_t^* = \text{VoteShare}_{t-1}^* + \varepsilon_t$

where VoteShare_t is the latent support at day t, VoteShare_{t-1} is the latent support on the prior day, and $\varepsilon_t \sim \mathcal{N}(0,\sigma_t^2)$ is the independent across time news shock. The zero mean implies the news does not systematically favor any candidate, while the independence assumption precludes trends in the news. The star superscript indicates an inverse normal transform, $x^* \equiv \Phi^{-1}(x)$ where $\Phi(.)$ is the standard normal distribution function. This transform insures the range of the VoteShare variables is the entire real line like with the ε_t term. This equation can be iterated forward to yield,

(A2) $\text{VoteShare}_T^* = \text{VoteShare}_t^* + \nu_t$

where T is the election day, VoteShare_T is the election day latent support (presumed to be the actual election outcome), and $\nu_t \equiv \varepsilon_t + \varepsilon_{t+1} + ... + \varepsilon_T$.

Presuming that VoteShare_t is in the time t information set Ω_t, the best guess about the transformed election outcome is normally distributed, $\text{VoteShare}_T^* | \Omega_t \sim \mathcal{N}(\text{VoteShare}_t^*, \sigma_{vt}^2)$ where $\sigma_{vt}^2 \equiv \sigma_t^2 + \sigma_{t+1}^2 + ... + \sigma_T^2$. This means the time t prediction about the Democrat's election probability is,

(A3) $\Pr(\text{Win})|\Omega_t \equiv \Pr(\text{VoteShare}_T^* > 0)|\Omega_t = \Phi(\text{VoteShare}_t^* / \sigma_{vt})$

Inverting equation (A3) and using equation (A2) this can be re-written as,

(A4) $\text{VoteShare}_T^* = \sigma_{vt} \times (\Pr(\text{Win})|\Omega_t)^* + \nu_t.$

Under the <u>efficient capital markets</u> hypothesis, the price of a contract paying a unit if Democrat's win the election should equal $\Pr(\text{Win})|\Omega_t$: $\text{price}_t = \Pr(\text{Win})|\Omega_t$, where price_t is the market price (odds) of the contract. Substituting this into the equation gives,

(A5) $\text{VoteShare}_T^* = \sigma_{vt} \times \text{price}_t^* + \nu_t$

When equation (A5) is estimated, it is possible to interpret the constant term: a positive (negative) constant indicates that prices have indicates unfavorable (favorable) bias for

the Democrats.[37] A transformation of equation (A5) shows that the (efficient market) price at any time is the probability the candidate *actually* wins,

(A6) $\text{price}_t = \Pr(\text{VoteShare}_T^* > 0) \equiv \Pr(\text{Win})$

Since equation (A6) is not conditioned on any information set, it can be directly tested using every observation. After grouping the data into price ranges, the proportion of candidates which eventually win should match the midpoint of the price range.

Imposing some additional structure on σ_{vt} give additional equations which can be estimated. The weak-form efficiency equation considers a time differenced version of (A5),

(A7) $\text{price}_t^* = ((T-t)/(T-t-1))^{0.5} \times \text{price}_{t-1}^* + \varepsilon_t$

where we presume for simplicity that the standard errors are equal, $\sigma_s=\sigma \ \forall s$ (this is necessary to ensure the equation estimated in the text is concave in the parameters; a more general version is considered next). The semi-strong form efficiency equation is,

(A8) $\text{VoteShare}_T^* = (s_1^2(T-t)+s_2^2)^{0.5} \times \text{price}_t^* + \nu_t$

where we presume $\sigma_s=s_1 \ \forall t \neq 0$ and $\sigma_T=s_2$ (so $\sigma_{vt}=(s_1^2(T-t)+s_2^2)^{0.5}$). In this more general error form, the s_1 term represents the time-varying uncertainty (presumed to be *a priori* identical across days), and s_2 is time-invariant uncertainty (say uncertainty about the voters' preferences). Notice that both of the equations (A6) and (A7) are estimable using observed data. Because we treat the s_i terms as parameters to be estimated, equation (A7) must be estimated using NLLS. Also, since ν_t is heteroscedastic and autocorrelated, we use bootstrapped standard errors.

As an aside, notice that the main equations (A7) and (A8) also roughly hold in a linear form which omits the starred superscripts (the inverse normal transform). Suppose that the elections are competitive so VoteShare_T^*, $\text{price}_t^* \approx 0$ (the untransformed values are near one half). In this case a linear Taylor series is valid, and using the properties of the normal distribution we have the approximations,

(A7') $\text{price}_t \approx 0.5(1-((T-t)/(T-t-1))^{0.5}) + ((T-t)/(T-t-1))^{0.5} \times \text{price}_{t-1} + e_t$

where $e_t \equiv \phi(0)\varepsilon_t$ with $\phi(.)$ as the standard normal density and,

(A8') $\text{VoteShare}_T \approx 0.5(1-(\sigma_1^2(T-t)+\sigma_2^2)^{0.5}) + (s_1^2(T-t)+s_2^2)^{0.5} \times \text{price}_{t-1} + v_t$

where $v_t \equiv \phi(0)\nu_t$.

Vote Share Market

Equation (A2) gives the law of motion for vote shares. Under efficient markets a market for vote shares should be priced based on the best current estimate of the final vote totals, $\text{price}^{VS}_t = E(\text{VoteShare}_T|\Omega_t)$. Using equation (A2) this means $\text{price}^{VS}_t =$

[37] To see this, suppose the contract price is set as, $\text{price}_t = a + \Pr(\text{Win})|\Omega$ where $a>0$ ($a<0$) indicates favorable (unfavorable) bias for the Democrats and $a=0$ indicates efficient markets. Substituting this into equation (A4) and taking a linear expansion (which is valid for a close election, $\text{VoteShare}_T^* \approx 0$) yields,

$\text{VoteShare}_T^* = -(a\sigma_{vt}/\phi(0)) + \sigma_{vt} \times \text{price}_t^* + \varepsilon_i$

where $\phi(.)$ is the standard normal density. Since $\sigma>0$, if the constant is positive (negative) then $a<0$ ($a>0$). If the constant is zero, then efficient markets holds.

VoteShare$_t$. This can be used to determine the relationship between efficient prices in a winner take all and vote share market. Applying equations (A2) and (A5) yields,

(A8) $\text{price}_t^* = \text{price}^{VS}{}_t^* / \sigma_{vt}$.

Case Study Framework

Following Campbell, Lo and MacKinlay (1997), we consider the path of prices following a specific event which in this case is a (potential) speculative attack. Normalize time so that t=0 when the manipulation begins. Define the *estimation window* as some period $t \in [-T_1, 0)$ prior to the manipulation. This period will be used to calculate the typical volatility of prices. We are interested in the path in prices during the *post-event window*, $t \geq 0$.

In particular we are interested in the post-event window distribution for the rate of return, cumulative return, and cumulative abnormal return defined in equations (1), (2), and (6). Given the framework in this Appendix (and presuming price_{t-1}^*, $\text{price}^{VS}{}_{t-1}^* \in \Omega_t$), then $R_t|\Omega_t$, $CR_t|\Omega_t$, and $CAR_t|\Omega_t$ are normally distributed. The variances for any of these terms can be calculated from prices during the estimation window. Tests of statistical confidence can be readily generated using these values.

Section B. Definition of Manipulation and Existing Literature

This section begins by providing definitions. *Fundamentals* are any information that influences the underlying value of an asset. A *speculative attack* is defined any trade, uninformed by fundamentals, intended to change prices. A (*successful) manipulation* is a speculative attack that achieves its objective of changing prices. A successful manipulation is usually not possible unless the trades influence the beliefs of other market participants. (An investor's *beliefs* are defined with respect to the fundamentals, as well as the future actions and beliefs of other investors). Consider a large purchase, which will tend to increase the price. If the position is rapidly unwound, no share will sell for more than the initial price unless the beliefs underlying prices change. Alternatively if investors believe this purchase reflects more favorable fundamentals or will lead other investors to buy, then higher prices are possible. Models formalizing this intuition are discussed below.

Our definition of manipulation differs from others which focus on the goal of investor profits. The reason we focus on market prices stems from the richer set of motives for manipulating prediction markets. While profit-seeking is the main objective of manipulation in traditional financial markets, investors in prediction markets may be willing to accept losses if this has large and lasting effects on prices. These manipulators might be primarily interested in the feedback effect of such prices. For example, in political prediction markets an investor could sell shares to lower prices and signal a candidate has weakened. This might influence the choice of undecided voters, either directly or through the media. The manipulator also might be interested in other indirect effects, such as a spillover into other financial markets such as the NYSE. We are agnostic on the exact incentives of the manipulating trader. As long as the manipulator's

goal involves a long-term change in prices and there is no new information—a common feature of the objectives listed above-- the market response should be similar.[38] Our goal is to focus on how markets respond to these attacks. Still they suggest care is needed in the empirical work. For example, rather than focusing on volume-weighted prices (reflecting the typical price a manipulator might get) we might be more interested in a time-weighted price (since an extended period with unusual price might attract attention, even if trading is light).

Our work complements two related papers. Hanson, Oprea, and Porter (2006) find that manipulators are unable to influence the predictive capacity of prices in an experimental prediction market.[39] Camerer (1998) conducts a field experiment at the horse-track. At the track a wager on a horse pays-off only if that horse wins the race, so prices can be stated in terms of probabilities. The author simulates manipulation by placing and then removing a large wager on a specific horse. The final price on this horse is virtually identical to that of a control horse, which has similar characteristics but whose price was not manipulated. We built on his innovative work using both observational data and field experiments. The markets we study are sufficiently different to warrant further investigation. For example, the incentives for manipulators may be different, with profit-making paramount at the track and other objectives outlined earlier playing a role in the political market.[40]

Manipulations are traditionally defined as attempt to profit from artificially changing stock prices. Allen and Gale (1992) divide manipulations into three categories: action-based (attempting to influence the fundamentals of the underlying asset), information-based (spreading false information), and trade-based (buying and selling shares). The first two are explicitly outlawed in the Securities and Exchange Act of 1934 and are not considered here. We evaluate several cases of trade-based manipulation, which involve large purchases or sales which are sometimes rapidly unwound in so-called pump-and-dumps. Allen and Gale (1992) show that the latter can potentially be profitable even in a rational expectations equilibrium, even without bubbles, if other investors believe the manipulator may instead be a well-informed insider. The key point is that the price movements are believed to convey information, and it is the information

[38]Some apparent speculative attacks may not be primarily designed to change prices. For example, a trader from another political market might seek to hedge his position (this is referred to as a lay-off bet) or might seek to learn the market's depth / resiliency. Still, these are costly activities and there are often far cheaper ways to obtain these objectives. For example a layoff bettor should try and spread his money across different markets to get the lowest purchase price, while the free TradeSports trading screen reports the top fifteen orders (both price and quantity) in the bid and ask queue.

[39] Hanson and Opreas (2004) advance a theoretical model arguing that the activities of manipulators increase market accuracy by covering the cost of information acquisition by non-manipulators.

[40] While our field experiment for the IEM Presidential contracts is similar to Camerer (1998), there are some key differences relating to timing and incentives. First, the track manipulations occurred far before the race started while a preponderance of the wagers is placed right before post time. Investments are more uniform in political stock markets, and the market is fairly thick even months before the election. Second, the payoff of a winning wager at the track is inversely related to the bet total on that horse. An insider has strong incentive to delay his wager until the last possible moment so as to not draw attention (and potentially additional bets) on his horse. Political stock market participants are more likely to infer that even our earliest price shocks were due to an insider, since there is no incentive to delay an investment (payoffs in these markets are fixed at the time of the wager). Third, our cases include markets where wagering is non-anonymous.

asymmetry which is central to this and other models discussed later. Various empirical papers have documented the existence of trade-based manipulation in traditional financial markets.[41]

A range of market microstructure models allows such investments to have long-term effects on prices. Rational investors may chase trends in prices, even when the underlying fundamentals are unchanged or only slightly perturbed. A survey of these dynamic models is presented in Brunnermeier (2001) and O'Hara (1995).[42] Past prices and volume can help forecast future values when there is information asymmetry and investors are learning about one another's private information (Blume, Easley, and O'Hara, 1994). It is sometimes optimal for investors to herd, to repeat the last observed action. In this case bad news may not be fully reflected in current prices, and the herd may be fragile with a small shock leading to a large price change (Bikhchandani, Hirshleifer, and Welch, 1992; Bulow and Klemperer, 1994). Similarly, following Keynes' beauty contest interpretation of financial markets, investors may all collect the same kind of information and ignore others (Froot, Scharfstein, and Stein, 1992). There also may be multiple equilibria in which case large price changes can be triggered by a sunspot, an uninformative public information revelation, or small changes in fundamental parameters (Cass and Shell, 1983; Romer, 1993). And finally if noise traders or other non-rational agents are the marginal traders, investments not based on changing fundamentals can have long-term effects on prices.

A common theme from all of these models is that prices do not serve as a sufficient statistic for public information. This would call into question the predictive capacity of prediction market.

Section C: A Brief History of the NY Races

Many readers are familiar with the contours of the national races but unfamiliar with the state and local contests. The section seeks to offers a partial remedy. Table C1 lists the election outcomes of the races for Mayor of New York City from the creation of the office in 1897 to 1937. In the fourteen races over this period, Tammany Hall won nine contests. Before La Guardia's victories in 1933 and 1937, no candidate running as chiefly on the Republican platform ever won. La Guardia ran under the City Fusion, American Labor, and other labels as well as a Republican. (And even La Guardia ran under the City Fusion, American Labor, and other party banners as well as a Republican.) Tammany tended to fare well, winning with a plurality but not an absolute majority, when the opposition was divided between two or more major candidates. Only by running on a Fusion platform did a candidate defeat Tammany in the Mayor's race. Election lore has Tammany losing power to reformers after serious scandals broke out but then the reformers losing it back once the electorate grew tired of the reformers' Puritanism (including the enforcement of blue laws to close saloons and beer gardens on

[41]The more recent empirical evaluations have focused on stock pools during the 1920s (Mahoney, Jiang, Mei, 2005), "pump-and-dumps" of penny stocks (Aggarwal and Wu, 2005) or by brokers making personal trades (Khwaja and Mian, 2005), and cornering in futures markets (Merrick, Naik, and Yadav, 2005).
[42]While a bubble would allow prices to exceed an asset's fundamental value, rational bubbles are difficult to sustain when there is a known termination time as with prediction markets.

Sundays.) A constant theme in the anti-Tammany campaigns was to attempt to coordinate on the one candidate who could win and not to "waste" voters on the others. To the extent that the betting odds signaled which opposition candidate stood the best chance (e.g. Low versus Tracy in 1897), the betting markets could play an important role in the elections. Incumbency did not offer a huge advantage. In races where the incumbent major ran for re-election, this candidate won four of the races and lost three.

Table C2 shows the outcomes for the races for Governor of New York State. These races were in many ways simpler than the races for New York Mayor because both the Democratic and Republican parties were always in the contest and third parties rarely played a pivotal role. One complication was that the races occurred every two years, and turnouts and outcomes could be affected by the Presidential races. Note that the total voting turnout was significantly, roughly 20 percent, higher in years with Presidential elections than in years without. While the gubernatorial races were at times close in the early part of the sample, the Republican candidate won every race between 1898 and 1908. For the next decade, the two parties traded the office. But after 1922, the Democrats dominated. One might venture the claim that the Republicans did best upstate when the Democrats were strongest in the City. The Incumbent ran in 12 of the 23 Governor's races and won 8 times.

One note to inform discussions about the relative performance of New York market in aggregating information from city, state, and national race. Before speculating about whether from New York City it was easier to predict who would be the next Mayor, Governor, or President, it is important to note the pivotal role that the state of New York played in national elections during this period. New York was the largest state and possessed nearly one-fifth of the Electoral College votes a candidate needed to be elected President. According to Cherny (1997) p. 47, winning New York was key for the Democrats in the late nineteenth century. "In 1880, 1884, and 1888, the electoral votes of New York state were cast for the winning candidate. Had the other candidate carried New York in any of those contests, he would have won—and New York was very closely balanced between the two major parties. In those three elections, the winner and loser were, in effect, separated by only 1 or 2 percent of the New York state vote." To win, the Democrats needed to add to their base, New York and one of other swing state. "Such arithmetic makes it clear why the Democrats nominated New Yorkers for their Presidential candidates four times out of five between 1872 and 1888." Indeed of the 13 Democratic places at the head of the ticket between 1892-1940, eight spots were filled by New Yorker and two by New Jersey's W. Wilson. Several Republican nominees, including T. Roosevelt and C. Hughes, were also from New York. The Wall Street betting market would then have significant insider knowledge about qualities and secret lives of the candidates. The background helps explain why the Presidential prediction market did so well and why the 1916 outcome was such a surprise. New York went for Hughes as expected—and should have given him the lock -- but for the anomalous defection of California. As Tip O'Neil wisely put it, "All politics is local."

The nature of the political races – including very close votes, charges of fraud, the death of a candidate – created a number of contingencies that forced betting commissioners to address issues of contract interpretation. It is useful to review these events in this appendix. In the 1876 Hayes-Tilden contest, the election was essentially a draw with the political parties charging each other with fraudulently manufacturing votes.

The House of Representative eventually decided this highly contested election. The acrimony spilled over into the betting market, where John Morrissey, the leading New York pool-seller (pari-mutuel betting), opted to cancel the pools, returning the stakes minus his commission. This solution left many unsatisfied, contributing to the push in the next session of the New York legislature to outlaw pool-selling. *New York Times*, 11 Dec. 1876, p. 1; 25 April 1877, p. 4. In later years, betting commissioners handled contested elections by specifying the contract to be contingent on whomever actually took office and withholding payment until one side officially conceded. In the close 1884 election, betting lasted until the Friday after the election. *New York Times*, 9 Nov. 1884, p. 1. There were charges that Jay Gould used his control of the Associated Press wires to transmit false post-election results of voting results to take advantage of misinformed agents in the financial markets. In the 1888 contest, when Harrison won the Electoral College vote outright (233-168) and yet Cleveland very narrowly won the popular vote, settlement in favor of Harrison bettors occurred without a hitch.
In the inaugural race for Mayor of the unified City of New York in 1897, the independent candidate, Henry George, died in the last week of the campaign, throwing his supporters to the others. Several, but not all, of the betting commissioners, cancelled all of the existing bets upon this event, and then reopened a new round of betting. "A committee selected unofficially to decide on bets made before the death of Henry George has decided that all such bets stand except those which stipulated that all the candidates should remain in the field." *New York Times* 2 Nov. 1897, p. 3. Eventually his son, Henry George, Jr., ran in his stead. In the interim, the betting markets might have guided the anti-Tammany voters to the most viable contender. Another noteworthy episode was the 1905 contest when the margin of votes separating McClellan and W. R. Hearst was surprising narrow. Hearst, charging vote fraud, demanded a recount. Betting activity continued briefly after Election Day. The election was not finally settled until mid-December and the election bets were not paid until January. *Washington Post*, Jan. 1905.
In closely Presidential race of 1916, the leading betting commissioners refused to settle until November 23, almost two week after the polls closed. *Wall Street Journal*, 11 Nov. 1916, p. 2; *New York Times*, 23 Nov. 1916, p. 1.

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Table 1: Analysis of *TradeSports* 2004 Presidential Election Speculative Attacks

	September 13: 15:59-16:13 GMT Attack 1	October 15: 18:31-18:33 GMT Attack 2
Attack summary		
length (minutes)	14	2
price change in previous hour	-1.5	0
price change	- 12.8	-44.0
volume (shares)	6887	4416
volume ($)	$40,246.76	$21,000.42
profits (upper bound)	$1,634.94	-$2,735.50

Note: The profitability calculation presumes that the manipulator immediately unwinds his position through re-purchasing the share he has sold (a "dump-and-pump"). This is the upper-bound of profits since it presumes he can sell at the observed market prices following his attack; his actual price will be lower if his orders are executed after the other traders buying shares.

Table 2: Logit Regressions Explaining Electoral Outcomes by Race in Historical New York Markets

Dependent Variable: Victory or Defeat of a Candidate in a Contest

		President		**Governor**		**Mayor**	
		(1)	(2)	(3)	(4)	(5)	(6)
Constant	Coeff.	0.694	4.216	1.279	7.207	-0.721	26.44
	St. Error	0.061	0.192	0.130	0.529	0.114	3.538
Democrat	Coeff.	0.445	3.094	-1.828	-3.171	1.894	-6.408
	St. Error	0.133	0.290	0.164	0.269	0.160	1.038
Incumbent	Coeff.	1.270	0.893	0.502	-0.695	-0.023	-6.761
	St. Error	0.078	0.094	0.140	0.233	0.080	0.933
Log (Odds	Coeff.	--	4.216	--	7.826	--	32.78
Price)	St. Error	--	0.474	--	0.611	--	4.331
Log Likelihood		-918.4	-487.2	-491.9	-335.8	-462.4	-98.00
Pseudo R2		0.180	0.616	0.166	0.437	0.144	0.819
No. of Obs.		1808	1808	864	864	790	790
Summary Statistics							
Outcome	Mean	0.690		0.572		0.567	
	St. Dev.	0.463		0.495		0.496	
Democrat	Mean	0.409		0.524		0.551	
	St. Dev.	0.492		0.499		0.498	
Incumbent	Mean	0.119		0.113		0.080	
	St. Dev.	0.883		0.594		0.639	
Log (Odds	Mean	-.594		-0.646		-0.812	
Price)	St. Dev.	0.508		0.302		0.638	

Notes:
Standard Errors are robust. In eq. (1) 9 failures are completely determined. In eq. (6), 144 failures and 9 successes are completely determined.

Table 3: *Ex Post* Net Winnings of Selected Betting Strategies in Historical New York Markets

		Bet Odds Price		Bet A Dollar		No. of
		No Vig	Vig	No Vig	Vig	Obs.
Betting on the Favorite						
All Races	mean	0.0958	0.0563	0.1075	0.0521	1914
	st. err.	0.3543	0.3347	0.6000	0.5700	
President	mean	0.0758	0.0356	0.0616	0.0085	1059
	st. err.	0.3274	0.3082	0.5444	0.5717	
Governor	mean	0.0822	0.0462	0.1059	0.0506	473
	st. err.	0.4164	0.3944	0.7106	0.6750	
Mayor	mean	0.1784	0.1362	0.2501	0.1875	378
	st. err.	0.3194	0.3022	0.5689	0.5404	
Betting on the Democrat						
All Races	mean	-0.0027	-0.0249	-0.1668	-0.2094	2664
	st. err.	0.4080	0.3851	1.0659	1.0126	
President	mean	0.1013	0.0777	-0.0331	-0.0814	1337
	st. err.	0.3676	0.3442	1.204	1.144	
Governor	mean	-0.2097	-0.2233	-0.5020	-0.5269	777
	st. err.	0.3972	0.3762	0.8800	0.8360	
Mayor	mean	0.0435	0.0124	-0.0141	-0.0634	545
	st. err.	0.4035	0.3803	0.8109	0.7704	

Note: The Vig is calculated as 5 percent of winning bets

Table 4: Impact of Manipulations and Wash Sales/Bluffs on Democratic Odds Price in Historical New York Markets

Dependent variable = Democrat odds price.

		Presidential Races				All Races			
		Manipulation		Wash/Bluff		Manipulation		Wash/Bluff	
Party	Days	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error
Republican	-7	0.0094	0.0096	0.0290	0.0138	0.0116	0.0090	-0.0008	0.0190
	-6	0.0013	0.0091	0.0037	0.0102	0.0094	0.0096	-0.0096	0.0141
	-5	0.0175	0.0106	0.0129	0.0107	0.0236	0.0111	-0.0038	0.0128
	-4	0.0014	0.0084	0.0091	0.0128	0.0042	0.0085	0.0144	0.0117
	-3	-0.0002	0.0077	-0.0058	0.0148	0.0029	0.0073	0.0021	0.0155
	-2	-0.0123	0.0079	-0.0202	0.0097	-0.0057	0.0075	-0.0122	0.0101
	-1	-0.0111	0.0084	-0.0286	0.0120	-0.0115	0.0078	-0.0095	0.0106
	0	-0.0306	0.0073	-0.0533	0.0077	-0.0284	0.0071	-0.0336	0.0098
	1	-0.0085	0.0089	-0.0348	0.0056	-0.0082	0.0089	-0.0107	0.0098
	2	-0.0081	0.0104	-0.0424	0.0135	-0.0101	0.0105	-0.0103	0.0144
	3	0.0140	0.0106	-0.0547	0.0098	0.0184	0.0109	-0.0390	0.0100
	4	-0.0176	0.0111	-0.0329	0.0127	-0.0212	0.0109	-0.0297	0.0105
	5	-0.0193	0.0124	-0.0494	0.0114	-0.0213	0.0116	-0.0456	0.0131
Democratic	-7	0.0834	0.0268	-0.0078	0.0114	0.0000	0.0234	-0.0150	0.0081
	-6	-0.0921	0.0065	-0.0117	0.0118	-0.0191	0.0133	-0.0247	0.0095
	-5	0.0391	0.0288	-0.0109	0.0069	0.0163	0.0164	-0.0216	0.0070
	-4	-0.0232	0.0255	-0.0143	0.0074	-0.0175	0.0108	-0.0188	0.0075
	-3	0.0093	0.0236	-0.0226	0.0065	-0.0143	0.0112	-0.0202	0.0055
	-2	0.0584	0.0197	-0.0171	0.0058	0.0024	0.0165	-0.0137	0.0057
	-1	-0.0163	0.0185	-0.0214	0.0058	-0.0087	0.0100	-0.0233	0.0059
	0	0.0594	0.0235	-0.0219	0.0052	0.0103	0.0112	-0.0181	0.0065
	1	0.1046	0.0256	-0.0120	0.0050	0.0439	0.0170	-0.0155	0.0056
	2	0.0420	0.0295	-0.0238	0.0064	0.0541	0.0160	-0.0287	0.0064
	3	0.0648	0.0241	-0.0359	0.0064	0.0606	0.0159	-0.0414	0.0089
	4	0.0553	0.0228	-0.0194	0.0056	0.0574	0.0183	-0.0130	0.0062
	5	0.0222	0.0096	-0.0242	0.0064	0.0460	0.0132	-0.0122	0.0066
Election Fixed Effects:				Yes				Yes	
No. of Obs.:				1235				2185	
R-squared:				0.942				0.926	

Notes: This table reports the results for two regressions measuring the impacts of manipulation events and wash or bluff bet events in: (1) presidential races and (2) all races. The standard errors are robust.

Table 5: Hypotheses Regarding Market Participant Behavior

	Hypotheses		
	Markets are Not Monitored	Beliefs Change | Markets Monitored	Beliefs Unchanged | Markets Monitored
Attack Market M_1	(↑,0)	(↑,↑)	(↑↓,0)
Attack Markets $M_1$and M_2	(↑,↑)	(↑,↑)	(↑↓,↑↓)

The cells are predicted responses in markets (M_1,M_2) following the speculative (purchase) attack listed in the left-most column. "↑" indicates an increase in asset price, "0" indicates prices do not change, and "↑↓" indicates an increase followed by decrease in asset price.

Table 6: Timing and Features of Investments in 2000 Presidential IEM

Manip Date	Market Attacked	Investment Democrat	Investment Republican	Investment Reform	Market Cap	Price Change Democrat	Price Change Republican	Price Change Reform
7/20	WTA	-$108.86	$119.72	$0	$8,544	-7.4¢ (-9.2¢)	0.9¢ (0.0¢)	---
7/30	VS	$120.00	-$19.60	$0	$4,717	0.0¢ (0.0¢)	0.0¢ (0.0¢)	---
8/10	WTA	$80.30	-$240.30	-$1.07	$16,679	0.2¢ (-0.3¢)	-1.2¢ (-0.2¢)	-0.1¢ (0.0¢)
	VS	$38.96	-$120.26	-$5.33	$5,003	0.0¢ (0.0¢)	-2.5¢ (0.0¢)	-0.9¢ (0.1¢)
8/28	WTA	$0	-$238.39	$0	$26,087	---	-1.2¢ (-0.7¢)	---
9/11	VS	$14.17	-$106.69	$0	$5,818	0.0¢ (-0.1¢)	-0.7¢ (-0.3¢)	---
9/20	WTA	-$240.16	$80.13	$0	$40,115	-0.5¢ (0.5¢)	0.0¢ (0.0¢)	---
	VS	-$81.05	$0	$0	$5,930	-0.7¢ (0.0¢)	---	---
10/3	WTA	$77.92	-$234.62	$0	$48,996	2.6¢ (1.5¢)	-5.4¢ (0.0¢)	---
10/14	VS	-$40.18	$97.20	$0	$8,206	0.0¢ (0.0¢)	1.0¢ (0.0¢)	---
10/23	WTA	$152.95	$0	$0	$62,504	3.1¢ (3.3¢)	---	---
	VS	$17.14	-$63.00	$0	$7,347	0.7¢ (-0.3¢)	-0.4¢ (0.0¢)	---
10/28	WTA	-$340.38	$0	$0	$68,828	-7.9¢ (-4.4¢)	---	---
	VS	-$224.48	$0	-$1.32	$7,266	-1.7¢ (0.0¢)	---	0.0¢ (0.0¢)
11/4	WTA	$209.64	-$42.61	$0	$71,521	6.5¢ (5.9¢)	-3.0¢ (-9.5¢)	---

Notes:

- In the investment column, a positive amount indicates a purchase and a negative amount indicates a sale.
- The market cap is the prevailing number of bundles (one share each of Democrat, Republican, Reform); a bundle can always be purchased or redeemed with the exchange at $1.
- The price change is the change in purchase price just prior and just after the attacks (this is between a quarter to a half hour). The number in parentheses is the change for the three hours prior to the attacks.
- On 10/28 all current holding were sold.

Table C1: Outcomes of New York Mayor's Race, 1897-1937

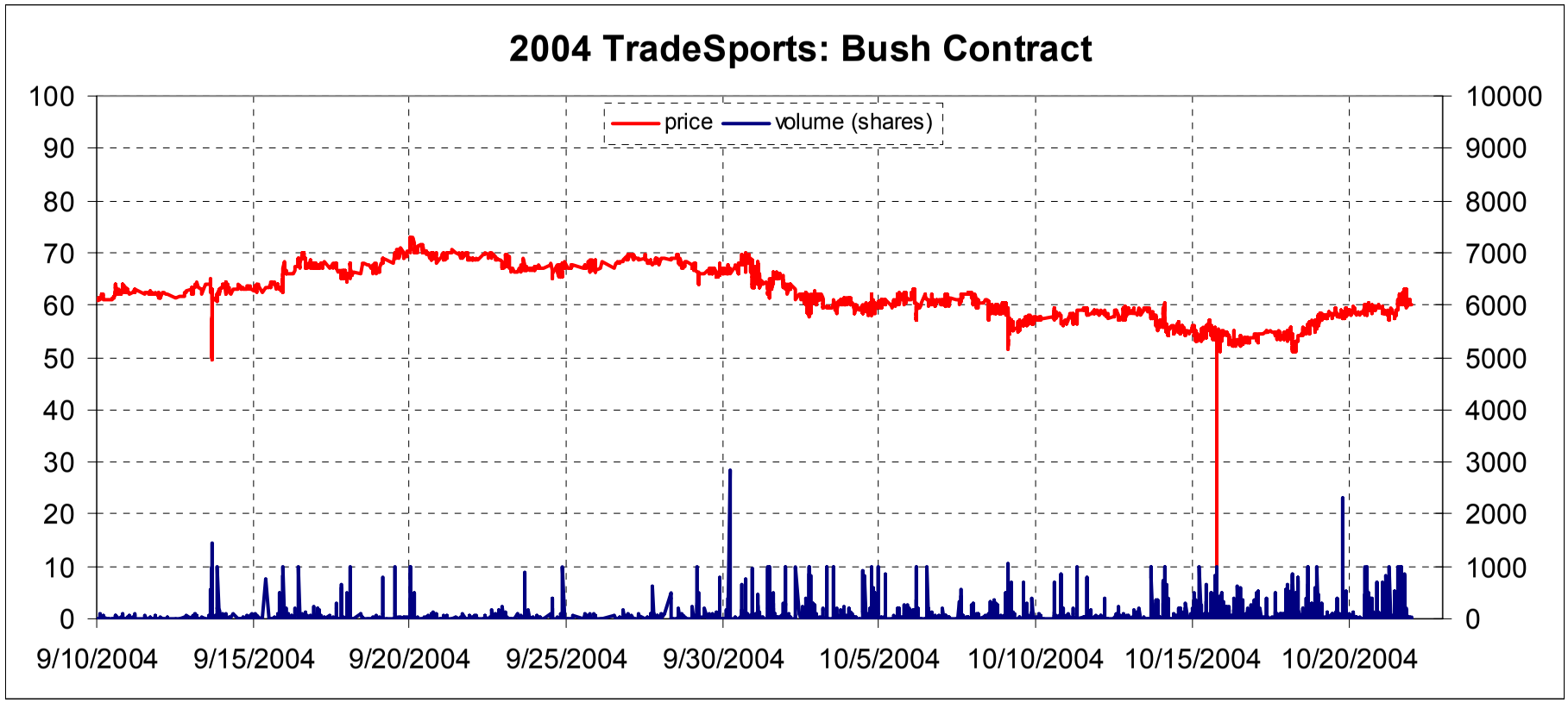
Party: Year	Democrat	Republican	Fusion	Independent	Socialist	Other	Total	Notes
1897	**Van Wyck**	Tracy		Low				
	233,997	101,863		151,540		44,230	531,630	H. George dies
1901	Shephard		**Low**					
	265,177		296,813				561,990	
1903		**McClellan**	Low					
	314,782		252,086			28,417	595,285	
1905	**McClellan**	Ivins		Hearst				Hearst demands
	228,397	137,193		224,929		15,676	606,195	recount.
1909	**Gaynor**		Bannard	Hearst				Term becomes
	250,378		177,304	154,187		22,198	604,067	four year
1913	McCall		**Mitchel**					Gaynor resigned in
	233,919		358,217			34,991	627,127	disgrace in past year
1917	**Hylan**	Bennett	Mitchel		Hillquit			
	313,956	56,458	155,497		145,332	20,586	691,809	
1921	**Hylan**	Curran			Panken			
	750,247	332,846			82,607	31,242	1,196,942	
1925	**Walker**		Waterman		Thomas			Walker beats
	748,687	346,564			39,574	26,272	1,161,097	Hylan in primary
1929	**Walker**		La Guardia		Thomas			
	867,522	367,675			175,697	53,795	1,464,649	
1932	**O'Brien**	Pounds		McKee	Hillquit			Walker resigned due
	1,056,115	443,901		234,372	249,887	269,585	2,253,860	to scandals
1933	O'Brien		**La Guardia**	McKee	Solomon			
	586,672	868,522		609,053	59,846	81,309	2,205,402	
1937	Mahoney		**La Guardia**					
	890,756	1,344,630				64,834	2,300,220	

Notes: Winner is in Bold.
Source: "Mayoralty" entry in Kenneth T. Jackson, ed., *Encyclopedia of New York City* (New Haven, CT: Yale University Press, 1995) pp. 736-39.

Table C2: Races for New York Governor, 1891-1936 (Bold wins)

	Democrat	Republican	Other	Total	Notes
1891	**Flower**	Fassett			
	582,893	534,956		1,162,853	
1894	Hill	**Morton**	Baldwin		
	517,710	678,818	23,525	1,275,671	
1896	**Black**	Porter			
	774,253	561,361		1,409,171	
1898	Van Wyck	**T Roosevelt**			
	643,921	661,707		1,359,190	
1900	Stanchfield	**Odell**			
	693,733	804,859		1,558,520	
1902	Coler	**Odell**			
	655,398	665,150		1,389,799	
1904	Herrick	**Higgins**			
	732,704	813,264		1,625,907	
1906	Hearst	**Hughes**			Anti-Tam. Dem
	673,268	749,002		1,492,219	
1908	Chanler	**Hughes**			
	735,189	804,651		1,653,856	
1910	**Dix**	Stimson			
	689,700	622,299		1,445,249	
1912	**Sulzer**	Hedges	Straus		Non-Tam. Dem
	649,559	444,105	*380,000*	1,611,672	
1914	Glynn	**Whitman**			
	470,206	686,701		1,486,875	
1916	Seabury	**Whitman**			Anti-Tam. Dem
	686,862	835,862		1,715,768	
1918	**Smith**	Whitman			
	1,009,936	956,034		2,192,970	
1920	Smith	**Miller**			
	1,261,812	1,335,878		2,962,645	
1922	**Smith**	Miller			
	1,397,657	1,011,725		2,588,961	
1924	**Smith**	T Roosevelt, Jr.			
	1,627,111	1,518,552		3,355,625	
1926	**Smith**	Mills			
	1,523,813	1,276,137		2,977,900	
1928	**F Roosevelt**	Ottinger			
	2,130,193	2,104,629		4,471,426	
1930	**F Roosevelt**	Tuttle			
	1,770,342	1,045,341		3,220,282	
1932	**Lehman**	Donovan			
	2,659,519	1,812,080		4,816,054	
1934	**Lehman**	Moses			
	2,201,729	1,393,638		3,937,199	
1936	**Lehman**	Bleakley			
	2,970,574	2,450,104		5,690,093	

Figures 1


2004 TradeSports: Bush Contract
price
volume (shares)
100
90
80
70
60
50
40
30
20
10
0
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
9/10/2004
9/15/2004
9/20/2004
9/25/2004
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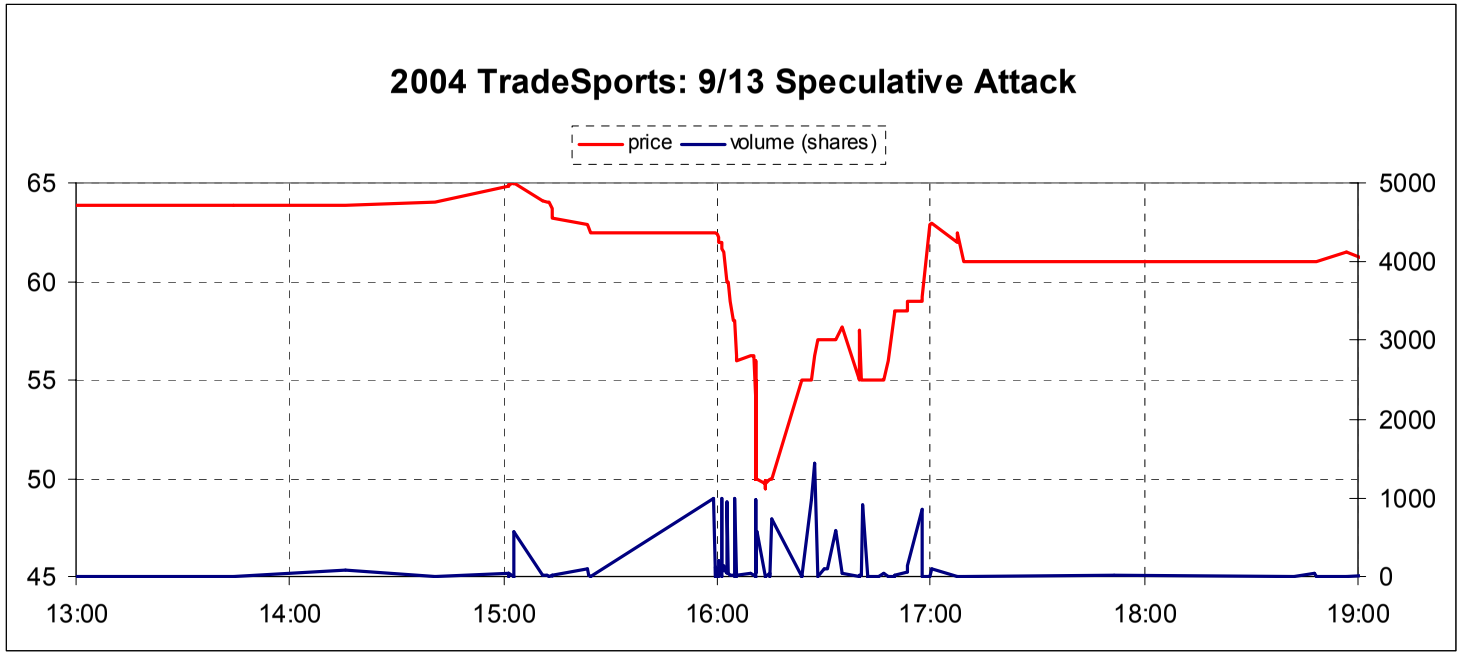
10/5/2004
10/10/2004
10/15/2004
10/20/2004

Figure 2


2004 TradeSports: 9/13 Speculative Attack
price
volume (shares)
65
60
55
50
45
5000
4000
3000
2000
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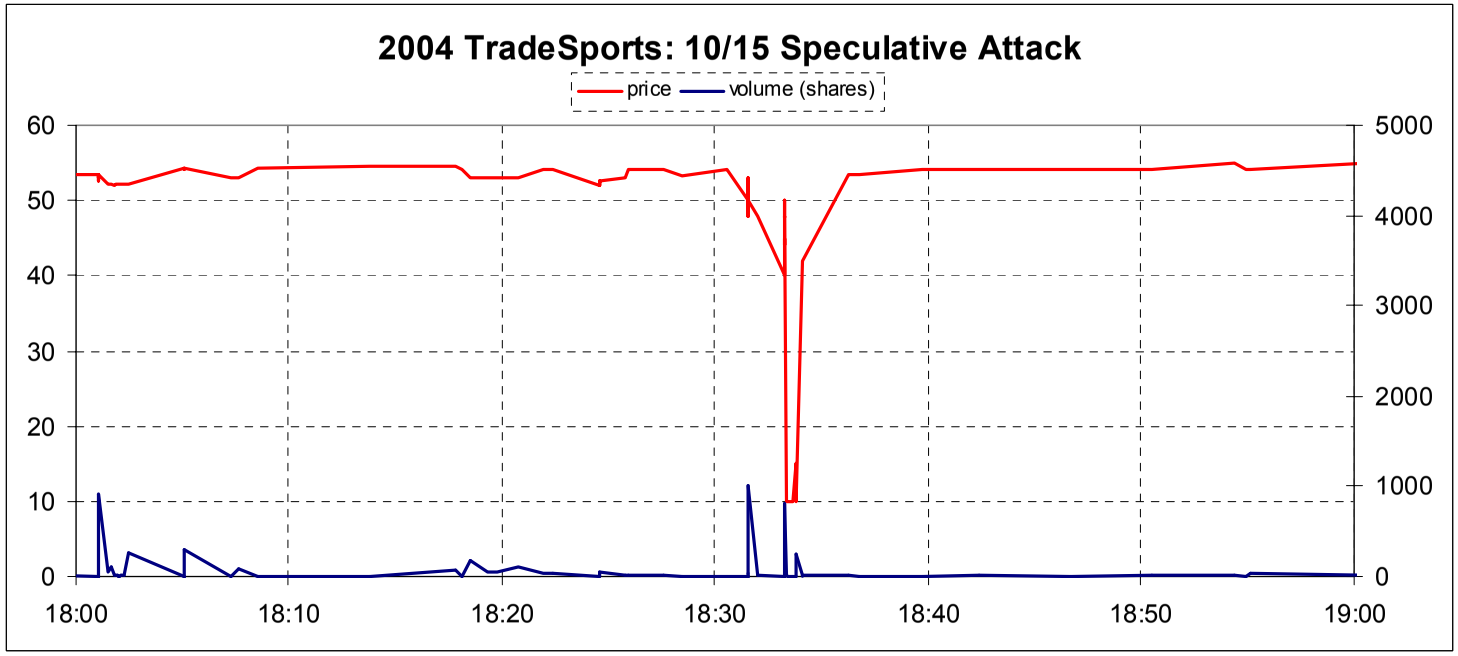
13:00
14:00
15:00
16:00
17:00
18:00
19:00


2004 TradeSports: 10/15 Speculative Attack
price
volume (shares)
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40
30
20
10
0
5000
4000
3000
2000
1000
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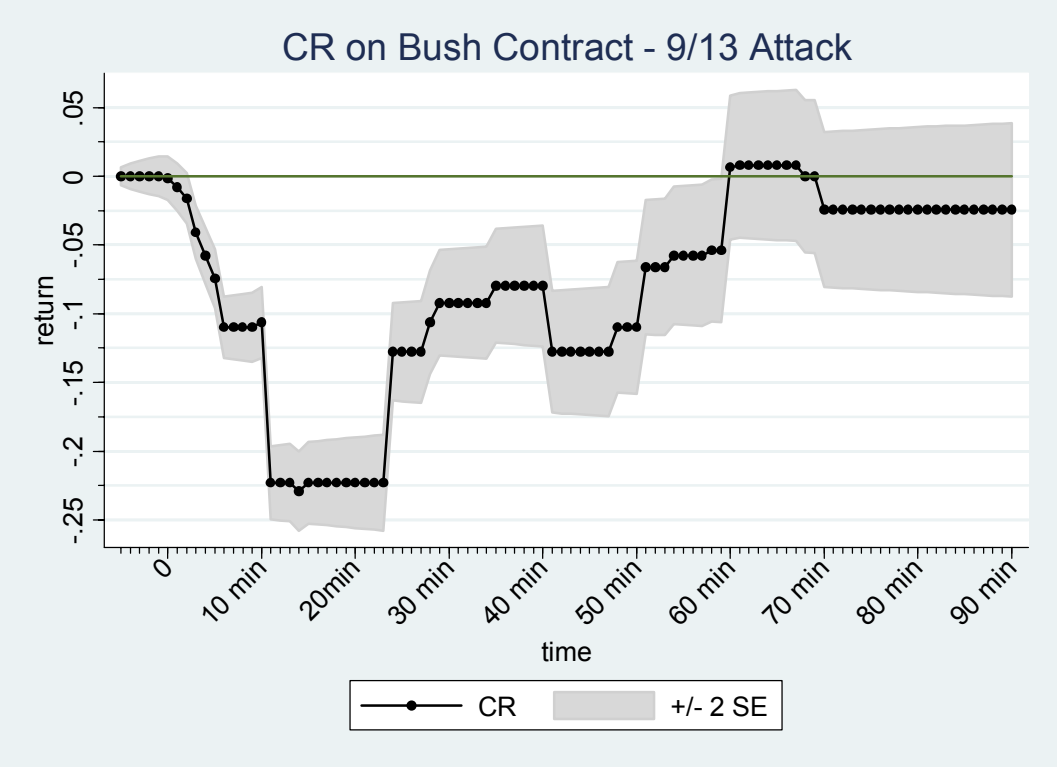
18:00
18:10
18:20
18:30
18:40
18:50
19:00

Figure 3: ***Tradesports*** **2004**



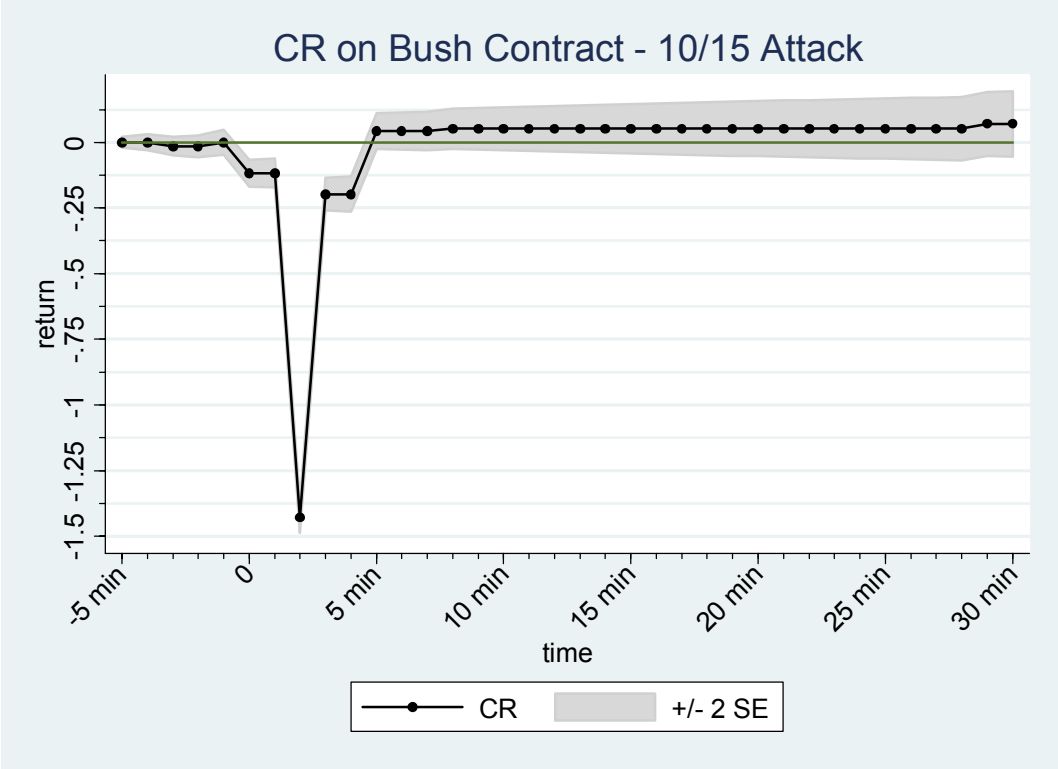
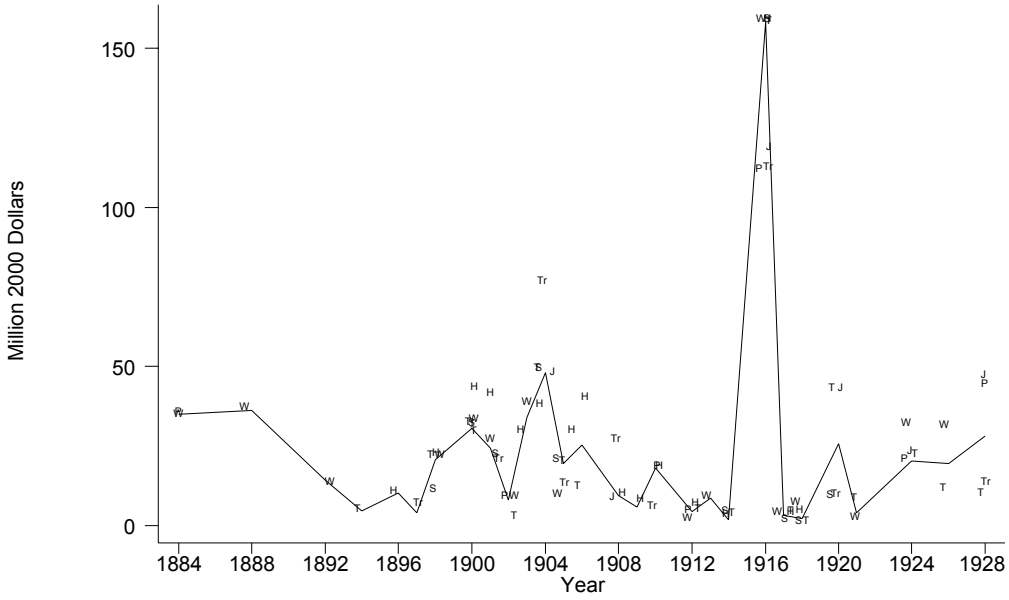


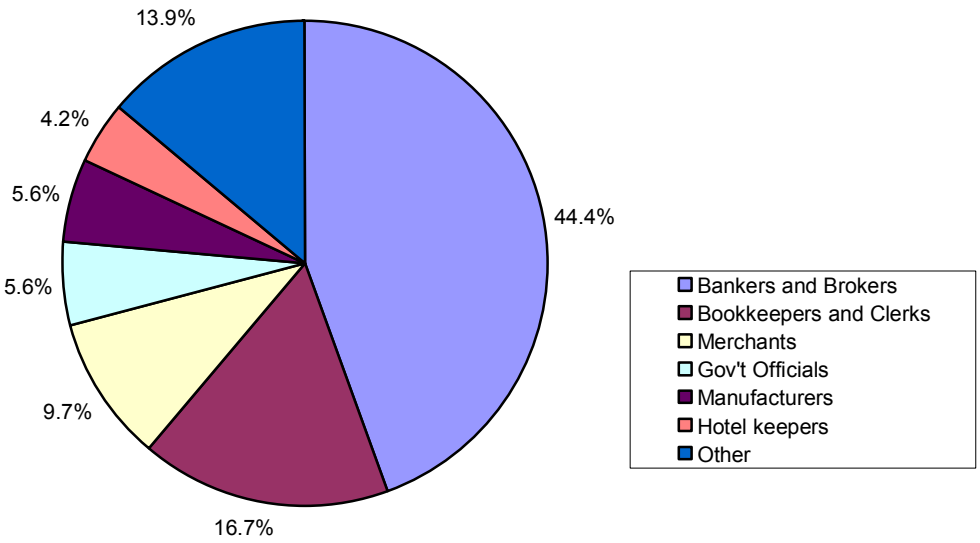
Figure 4: Estimated Volume in Historical New York Markets, 1884-1928



Key: J=Wall Street Journal; P= Wash. Post; H=NY Herald; S=NY Sun; T=NY Times; Tr=NY Tribune; W= NY World.

Figure 5: Comparing the 1900 Occupation Structure of Historical Bettors with the New York City Male Labor Force

Matched Election Bettors



New York City Males, aged 10 and over

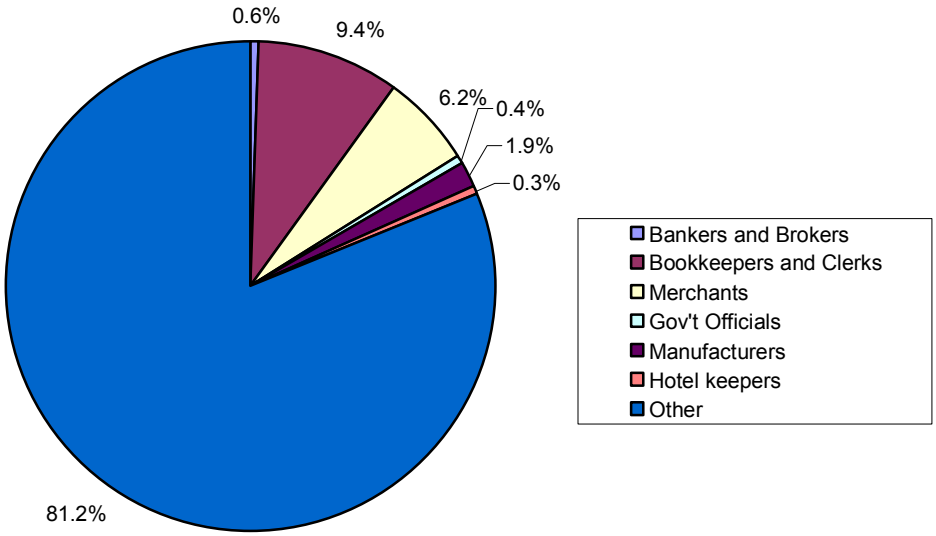
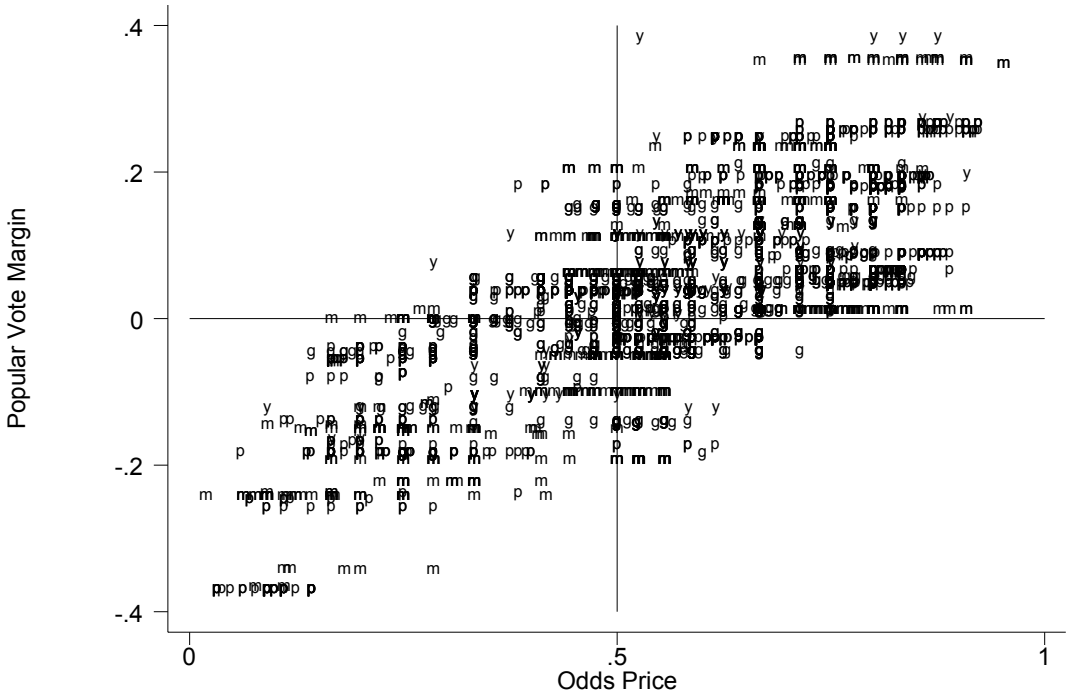


Figure 6: Historical New York Markets
(a) Popular Vote Margins versus the Odds Price



p=President, y=President in NY, g=Governor, m=Mayor

(b) Odds Prices and Outcomes with bootstrap standard errors

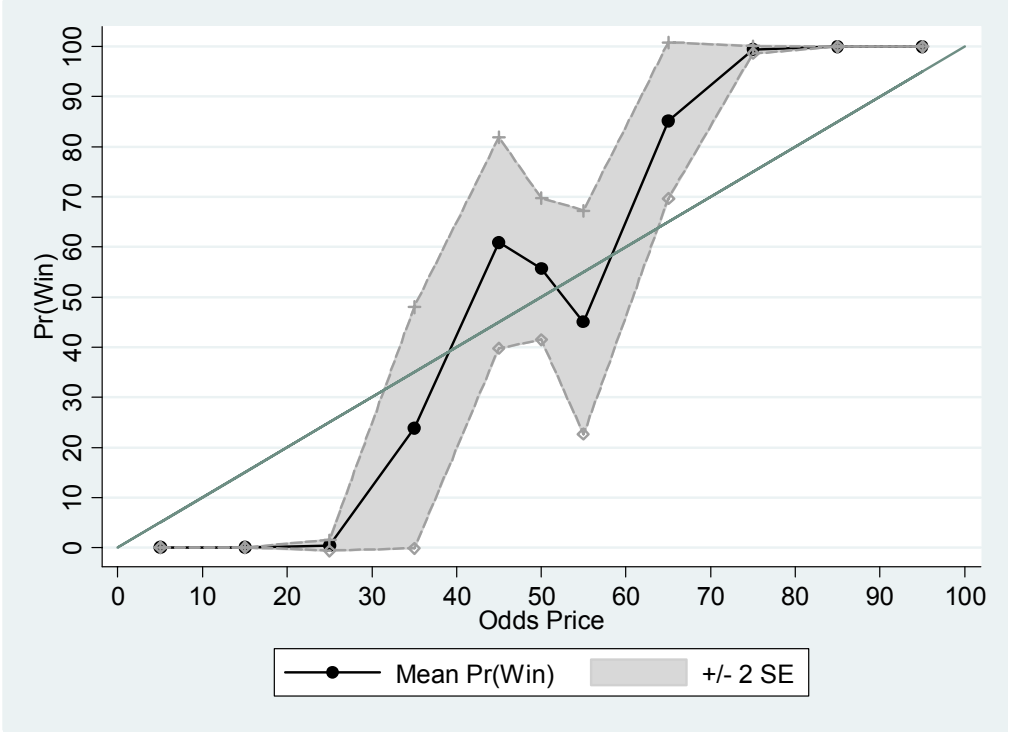
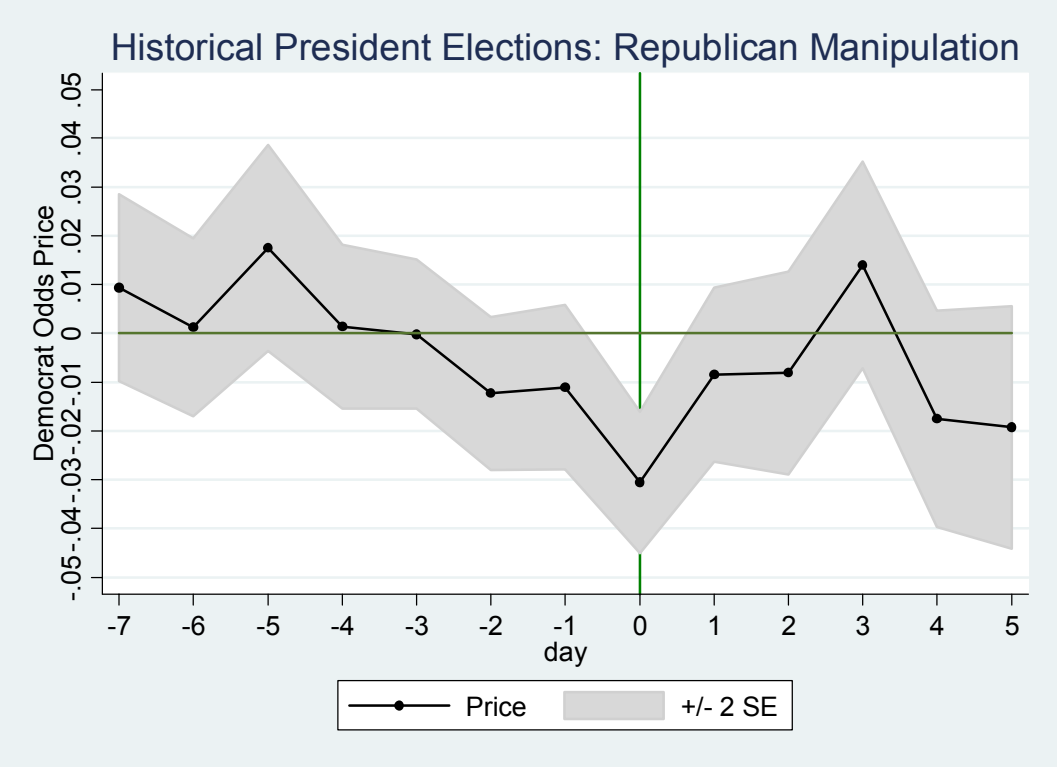


Figure 7(a) Manipulations in Presidential Races in Historical New York Markets



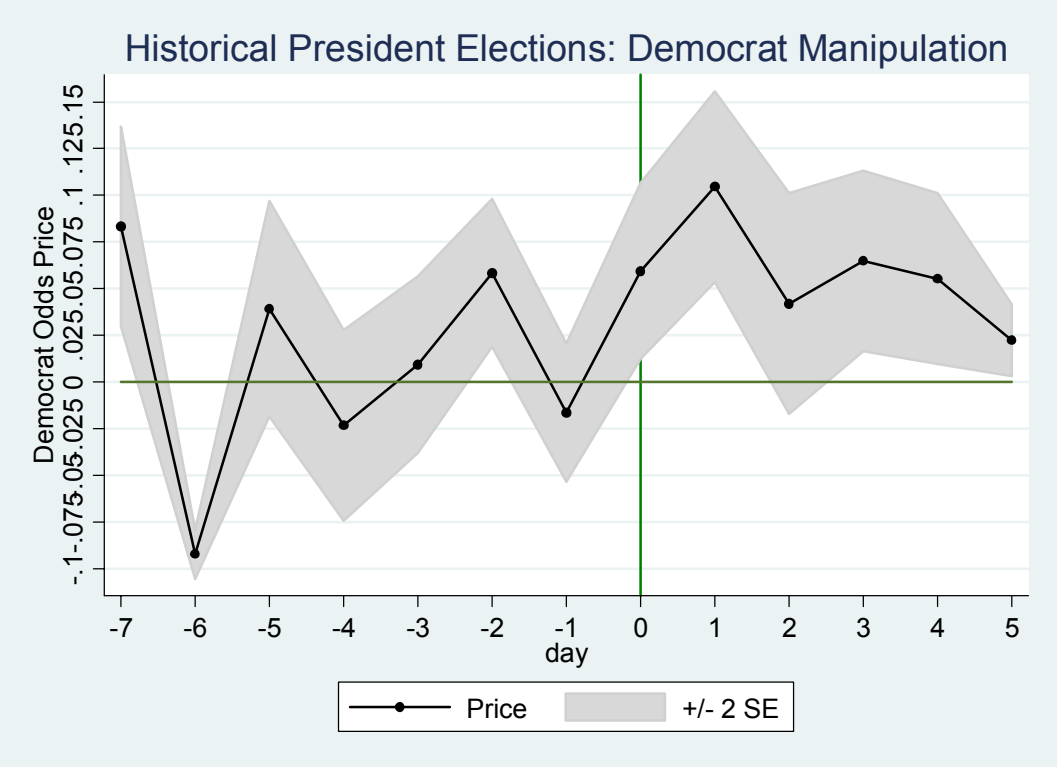
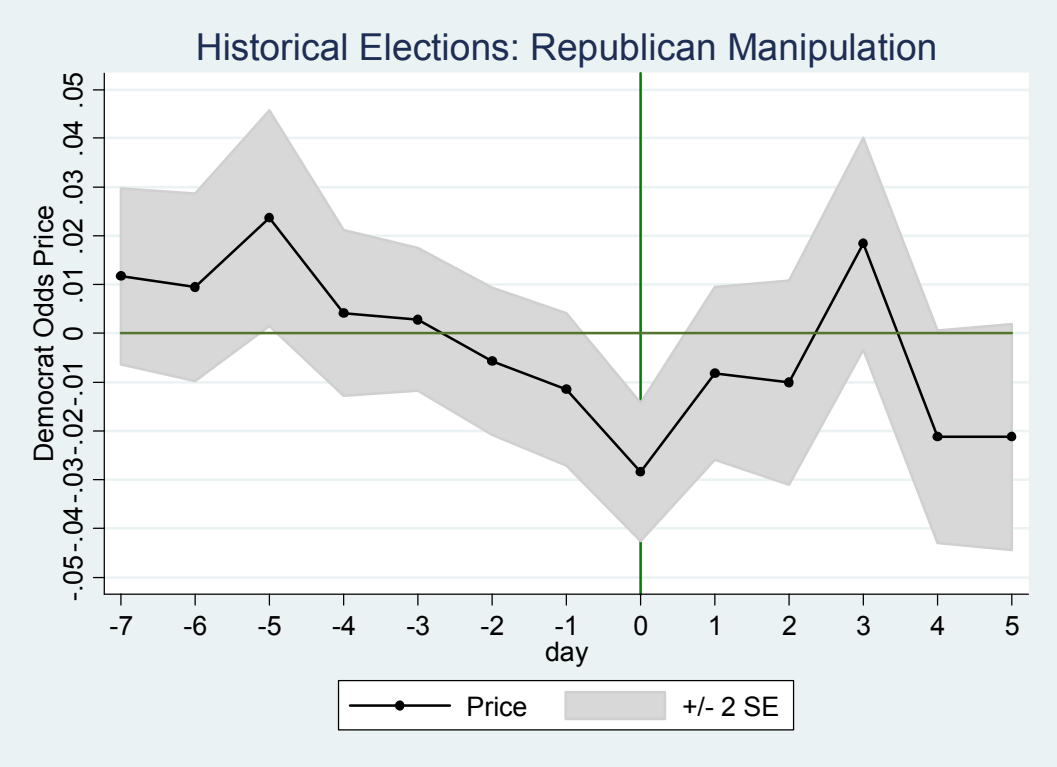


Figure 7(b) Manipulations in All Races in Historical New York Markets



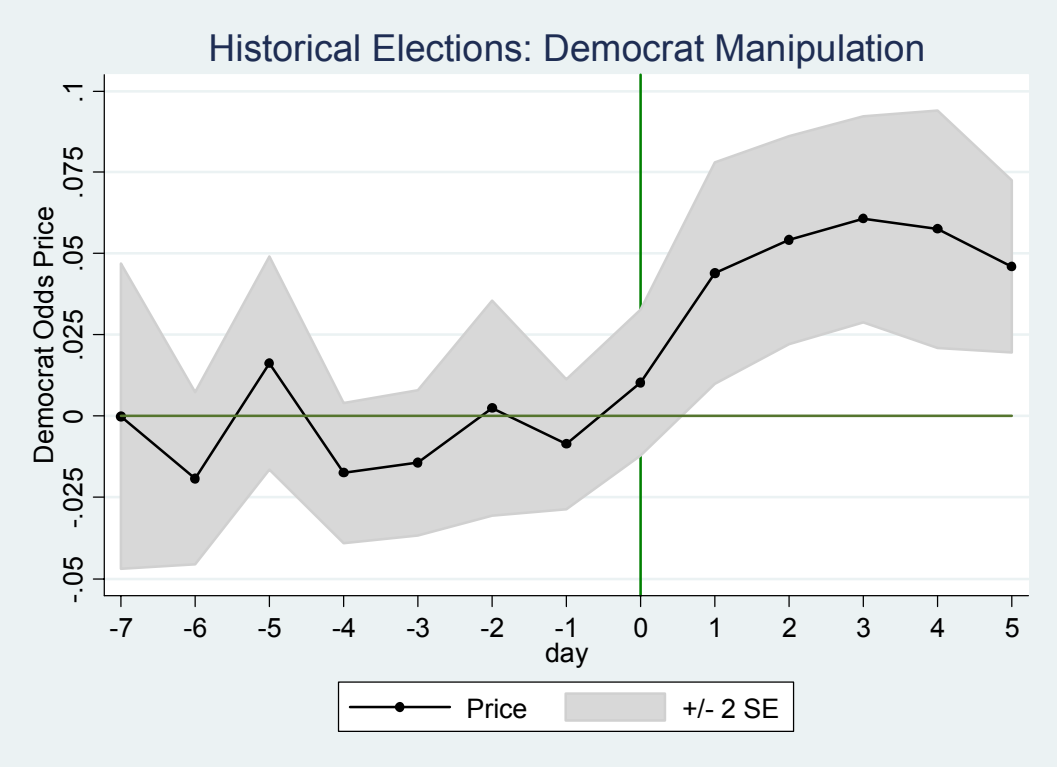
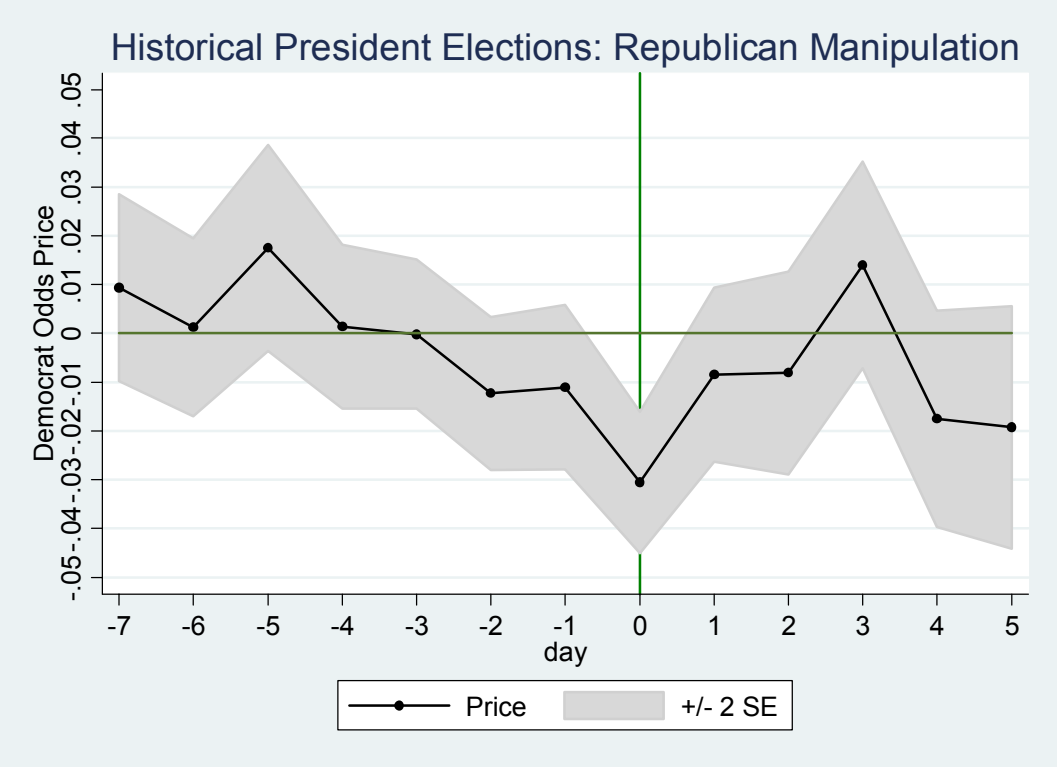


Figure 7(c) Results Combining Manipulations for Historical New York Markets



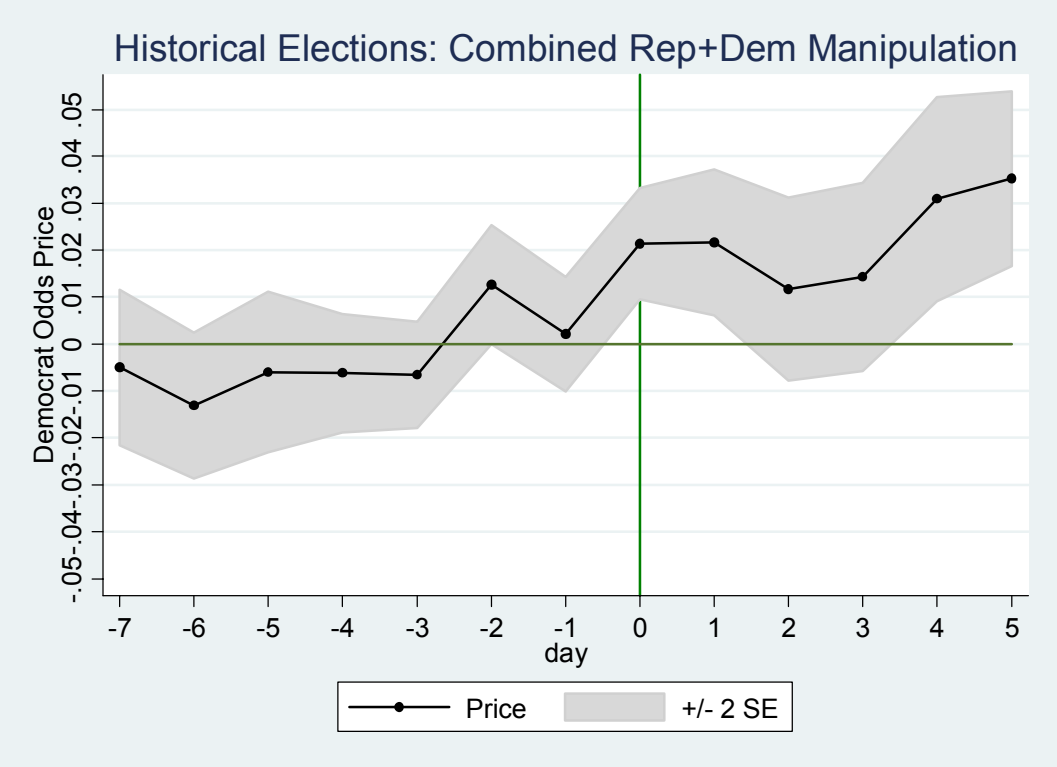


Figure 8: IEM 2000 WTA Market: Day After Election (CST)

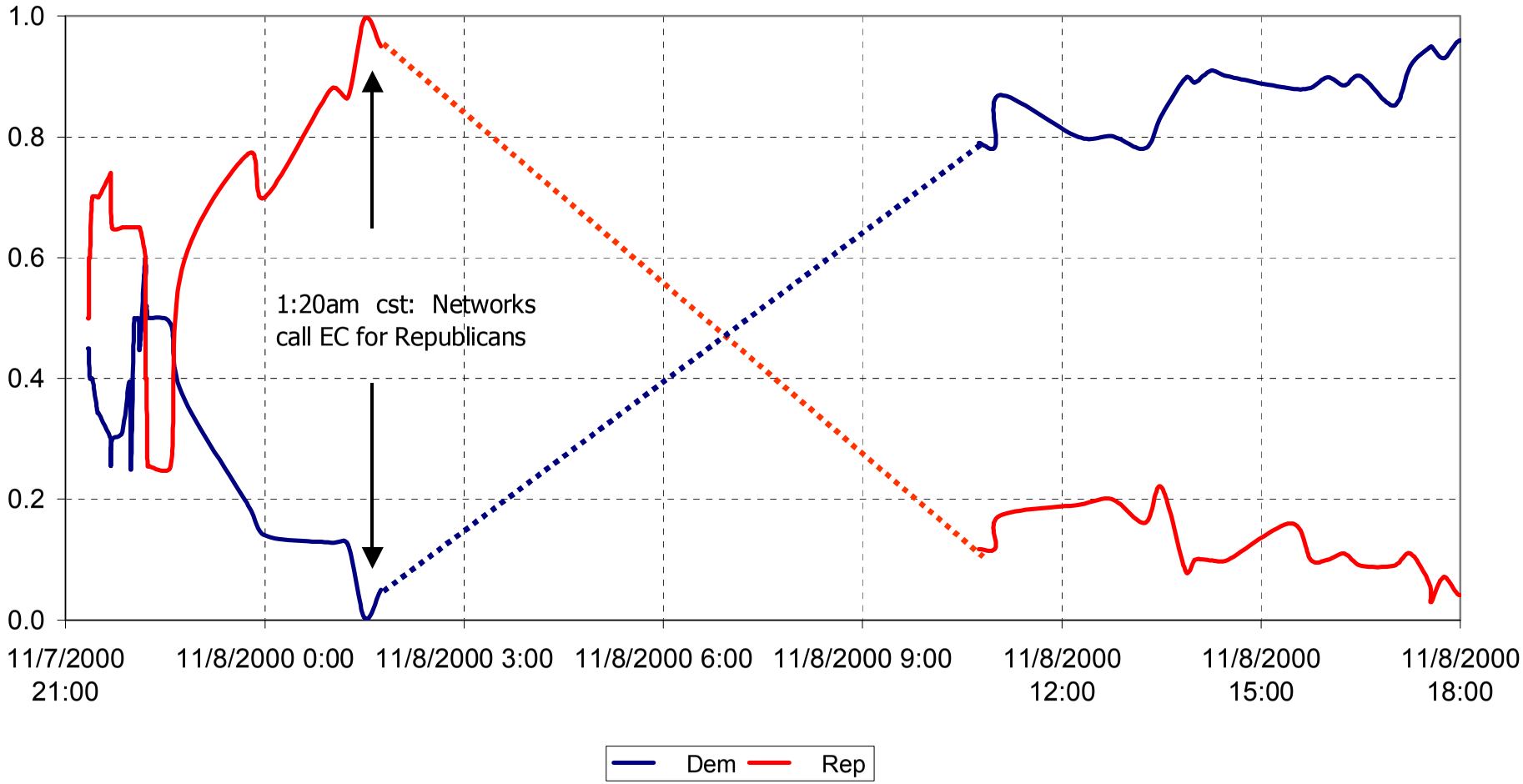


Figure 9: IEM 2000: 10/28/00 Trades (Sell Democrats in WTA+VS)

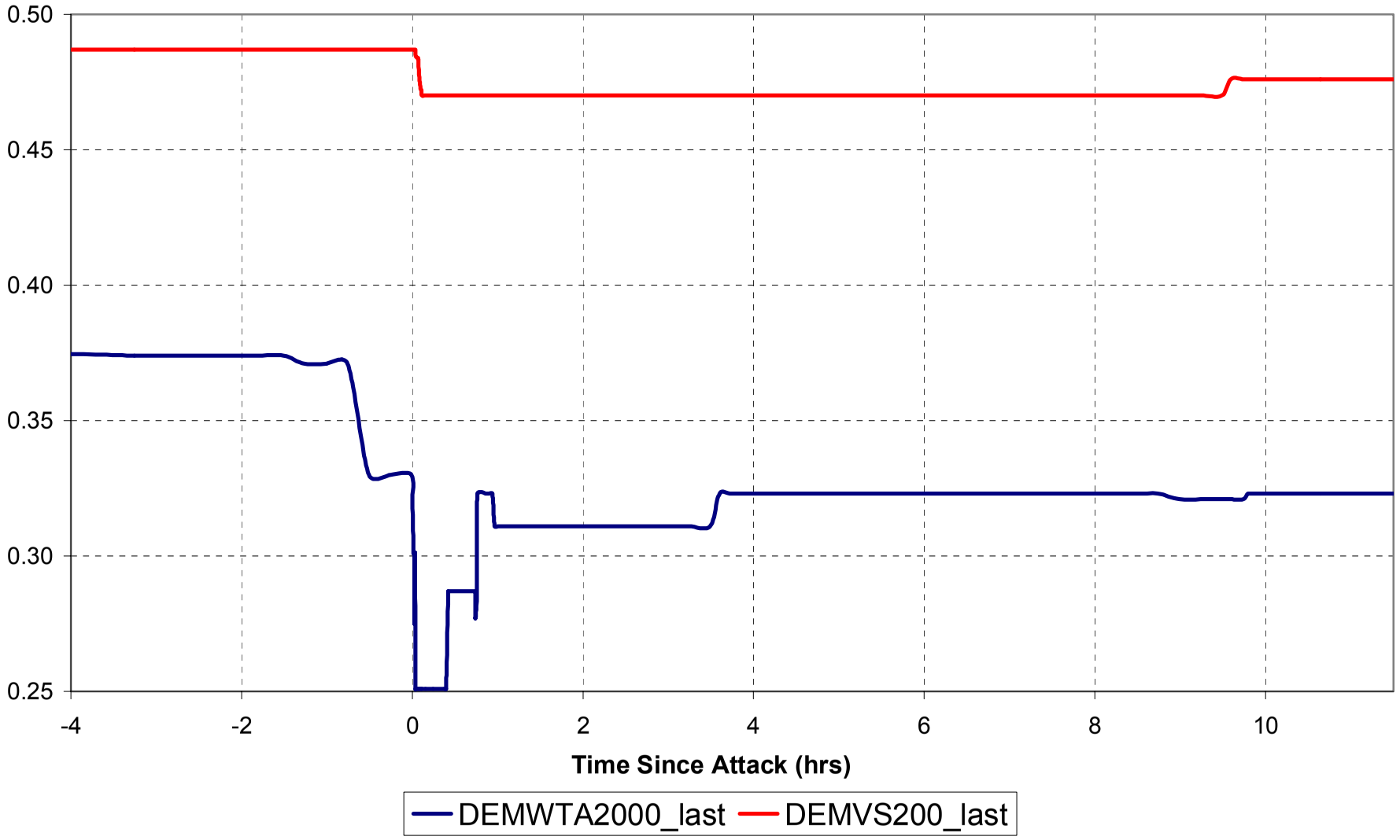


Figure 10: IEM 2000.
Mean CR in the Attacked Market over the Full Set of Trades (N=11)

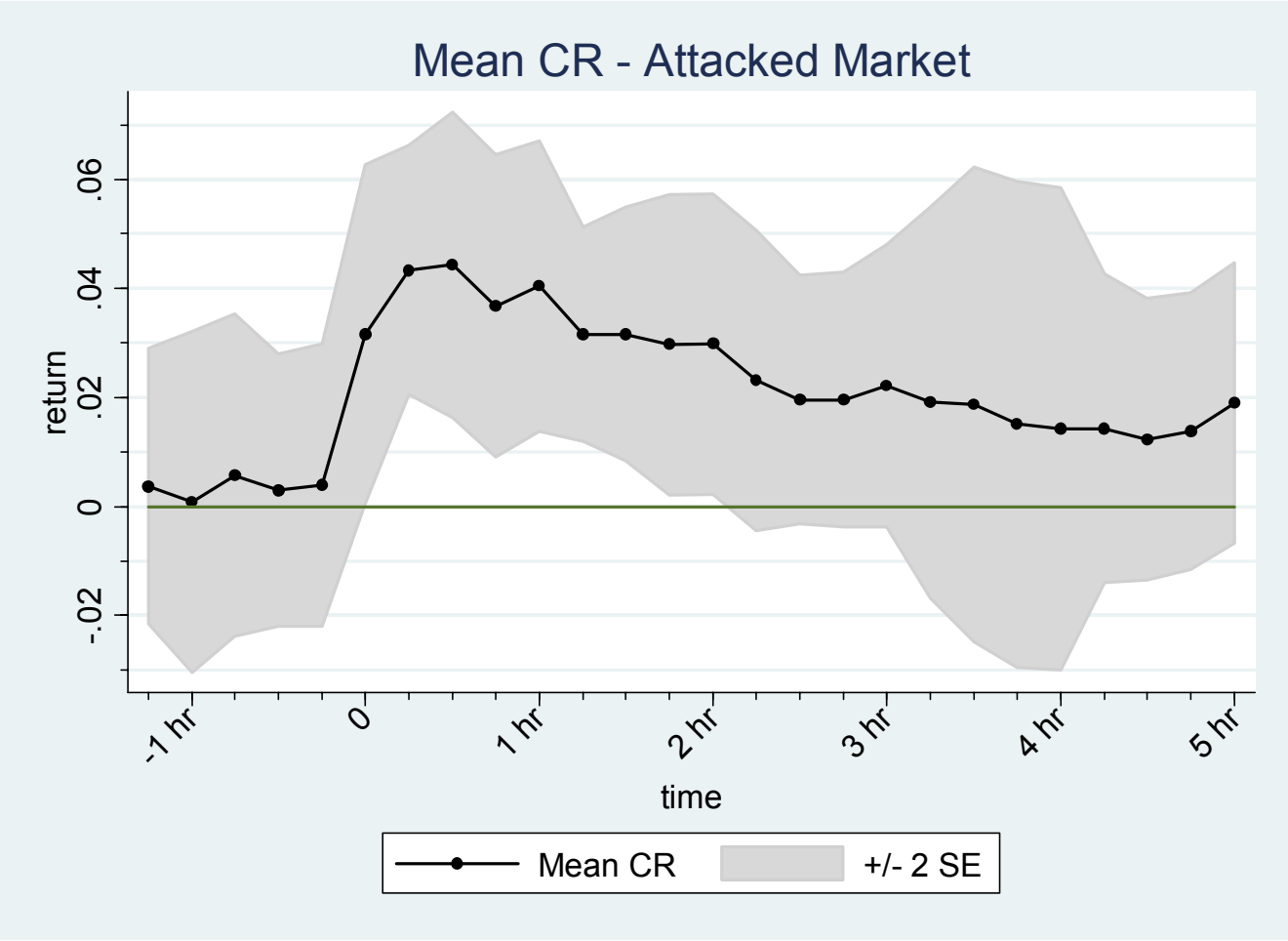
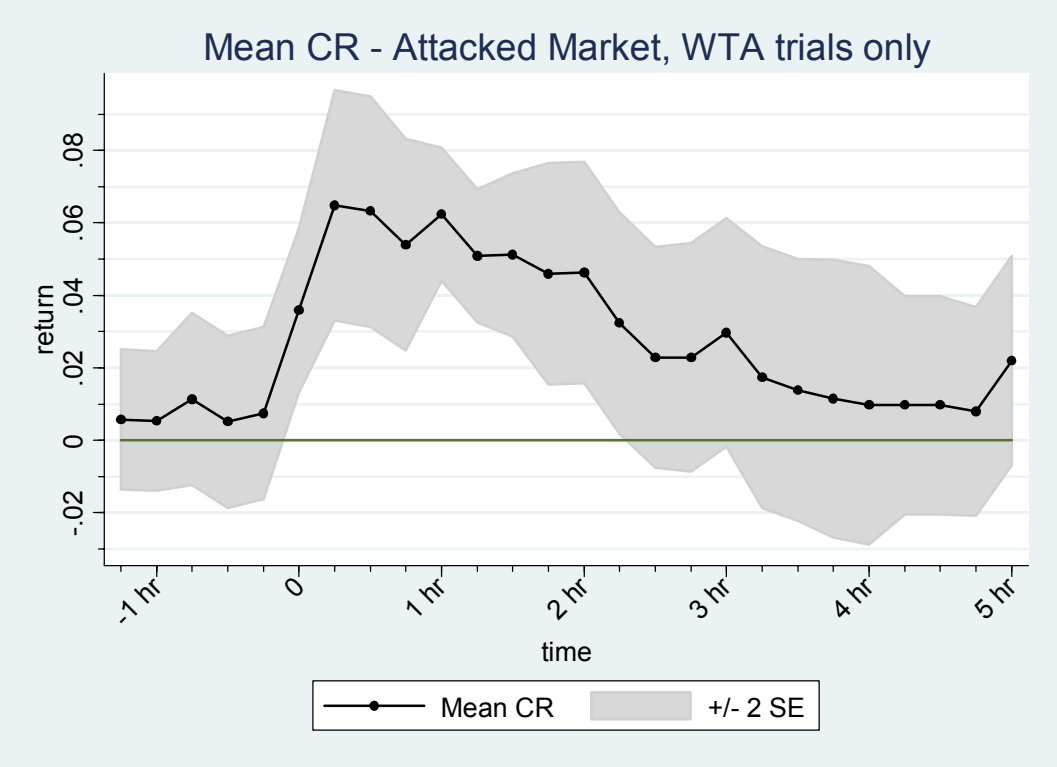


Figure 11: IEM 2000, by Market

(a) Mean CR in the Attacked Market for WTA-only Trades (N=4)



(b) Mean CR in the Attacked Market for VS-only Trades (N=3)

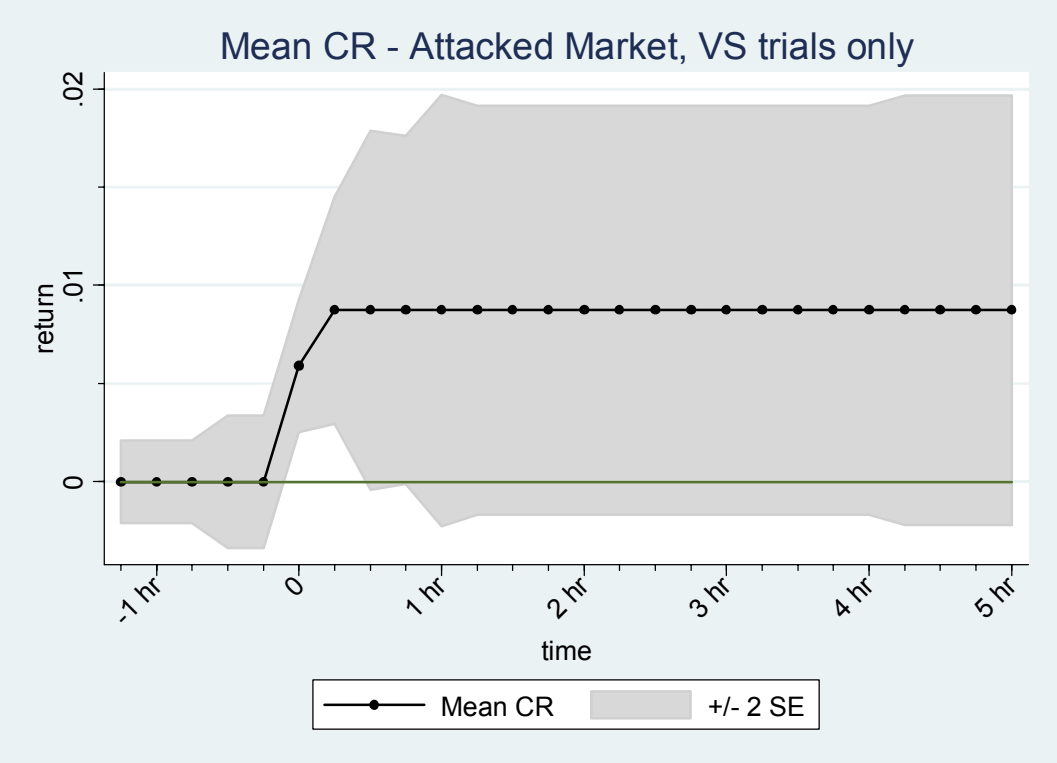
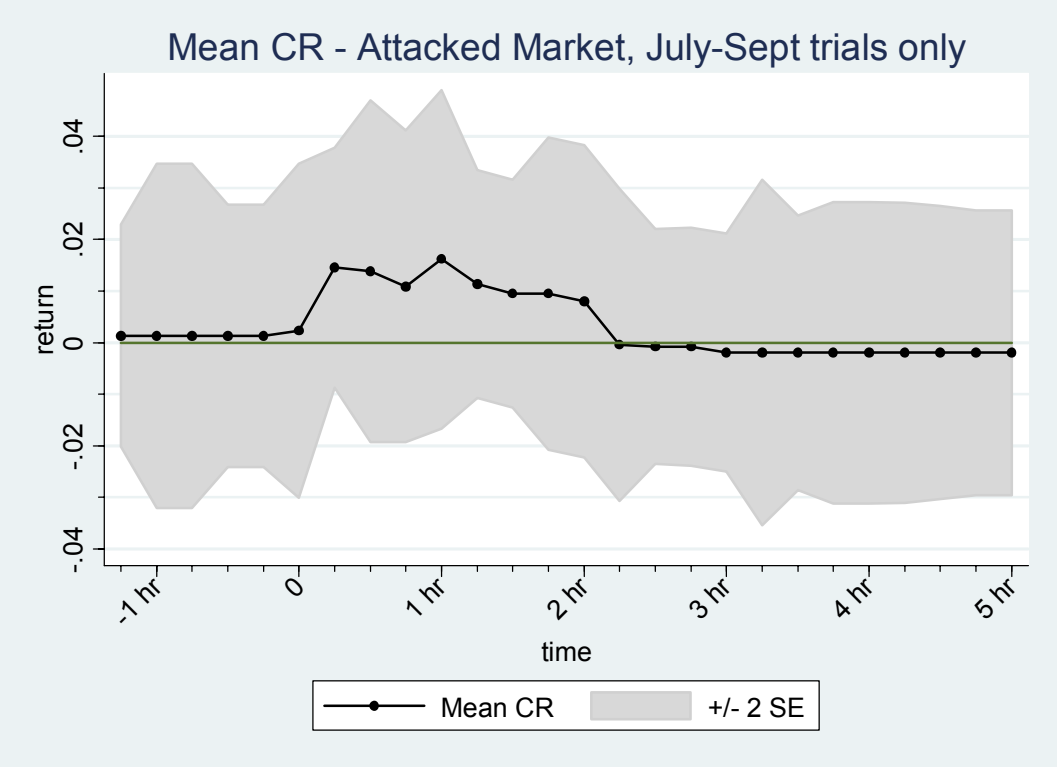


Figure 12: IEM 2000, by Time/Market Cap

(a) Mean CR in the Attacked Market for Early/Small Cap Trades (N=6)



(b) Mean CR in the Attacked Market for Late/Large Cap Trades (N=5)

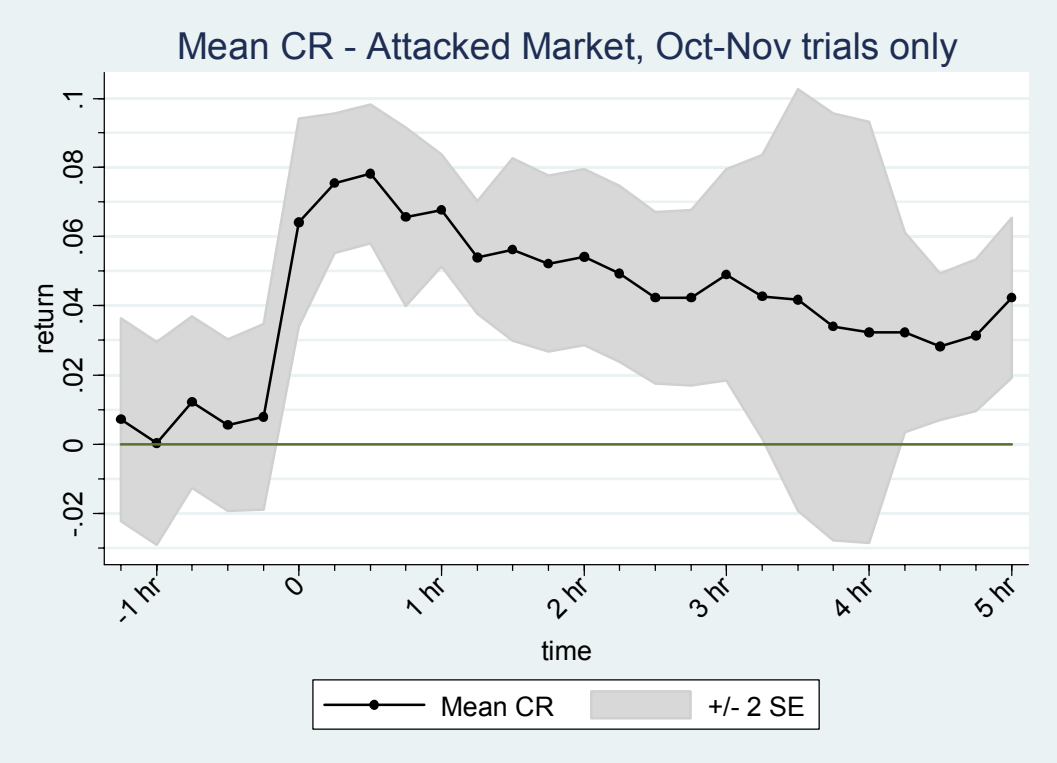
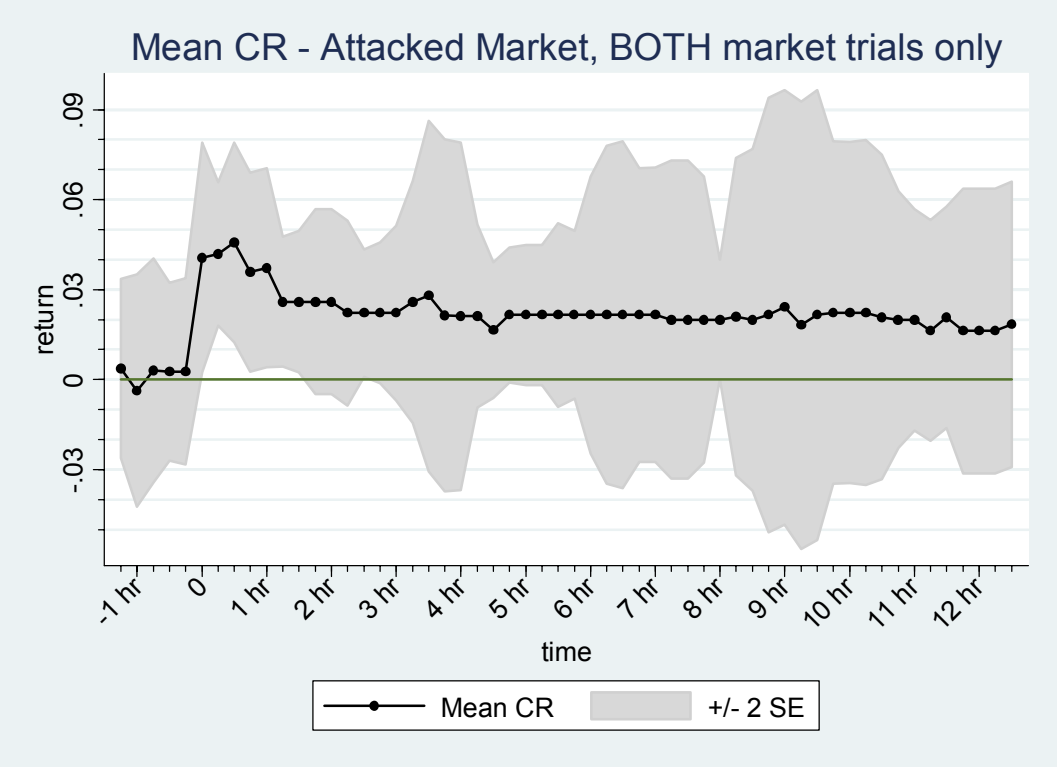


Figure 13: IEM 2000, Slow Reverting trials

(a) Mean CR in Two Market-Attacks (N=4)



(b) Mean CR in Trials with Democrat Purchases/Republican Sales (N=7)

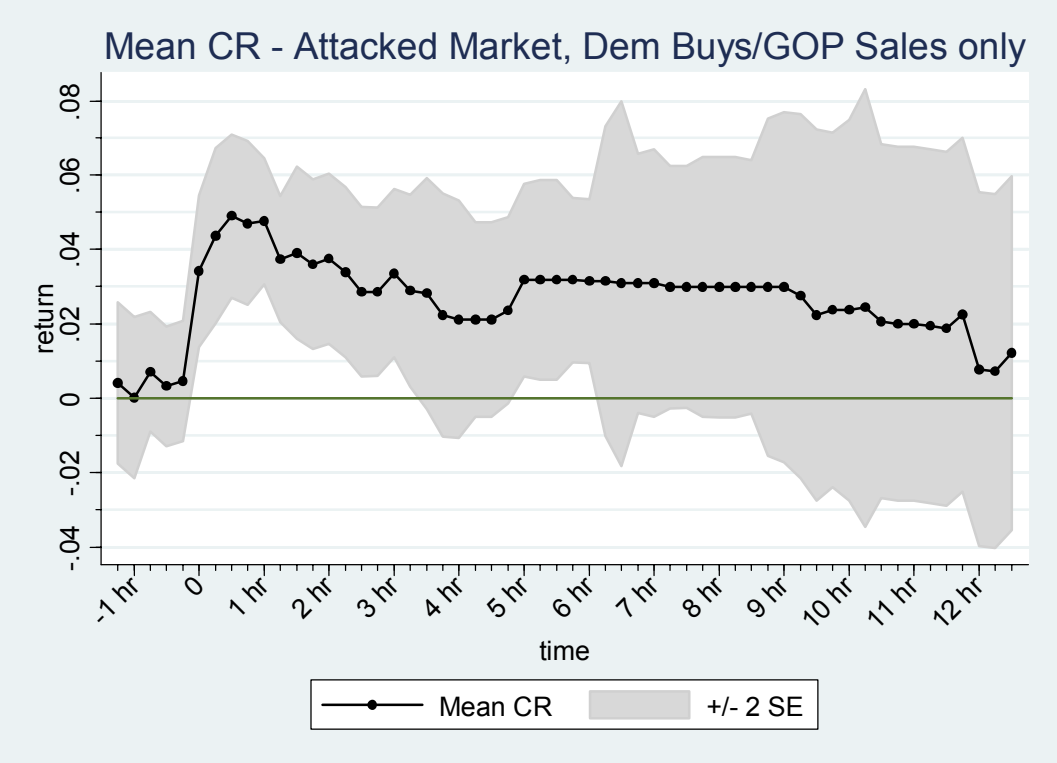
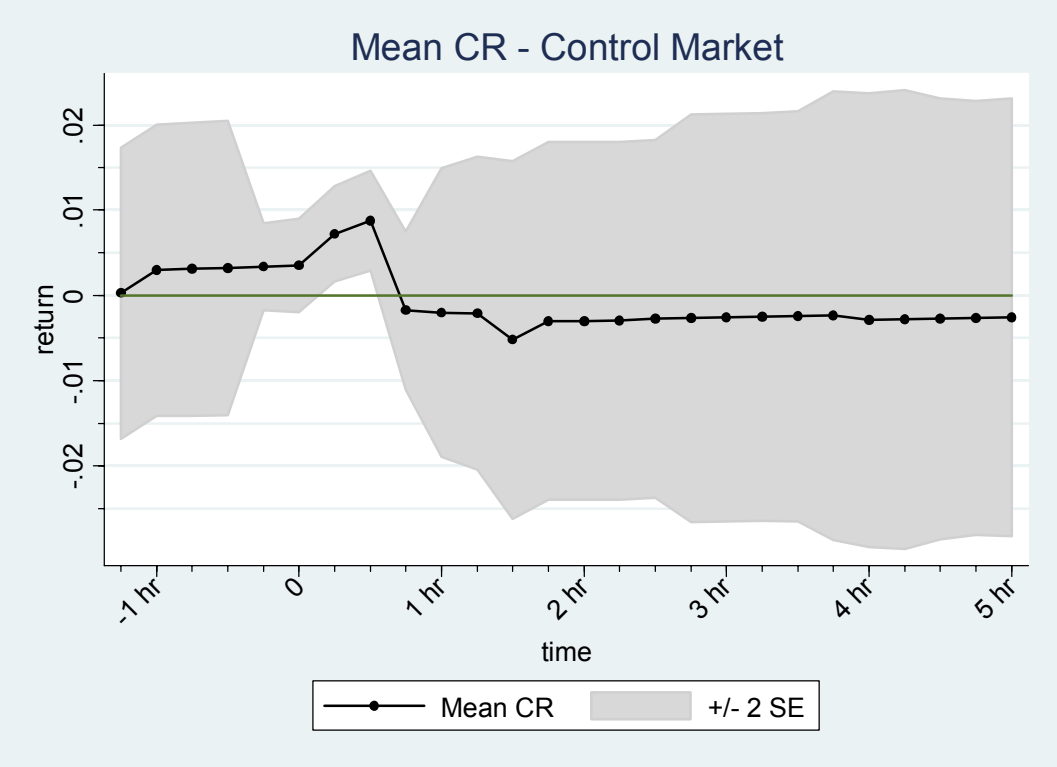


Figure 14: IEM 2000, Control Markets

(a) Mean CR (N=7)



(b) Mean CAR (N=7)