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Wishes, expectations and actions: a survey on price formation in election stock markets

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Abstract

With error-prone and biased individual traders, can markets aggregate trader information and produce efficient outcomes? We review election stock market evidence that suggests this does happen. Individual traders appear biased and error-prone consistently, yet these markets prove quite efficient in predicting election outcomes. We also review work which documents comparable, but substantially different, phenomena in related laboratory markets. In addition, we report the results from a new laboratory session which shows how we can create particular biases that mirror those in election stock markets. Finally, we discuss how combined laboratory and field experiments can help us understand trader/market interactions.

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1. Introduction

Building on the pioneering work of von Hayek (1945), most economists have come to believe that market prices summarize and reveal the relevant information of traders. The Hayek hypothesis (Smith, 1982) asserts that even when traders know very little about their environment or about other traders, market prices can lead to accurate forecasts of an asset's value. In this paper, we focus on a particular variant of this hypothesis: namely, when traders each have private, less-than-perfect information about an asset's true value, can a market aggregate this information so that it functions as if every individual trader has access to the collective information of all traders?

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That markets could accurately aggregate and disseminate the diverse information of traders runs counter to a substantial body of experimental evidence on individual behavior documenting anomalies. Much of this work has been conducted by psychologists who have demonstrated a variety of systematic departures from 'rational' decision making on the part of individuals. They have found, among other things, that individuals exhibit substantial information processing or judgement biases.

Judgement biases may affect markets in important ways. Traders' biases and errors may affect prices. Traders subject to a 'wishful thinking effect' (as described below) may increase the prices of assets correlated with things they want to happen while decreasing prices of other assets. Biases and errors may also affect the distribution of holdings and risks across traders. If markets are going to function according to the Hayek hypothesis, then they must somehow overcome these individual biases.

In this paper we survey evidence from field experiments on the ability of markets to efficiently aggregate information and the tendency of biases to affect prices and holdings. These experiments are election stock markets in which participants trade assets with payoffs ultimately determined by election outcomes. Two types of markets, 'vote share' and 'seats' markets (described in detail later), are designed to predict the vote shares of candidates and the seat shares of parties resulting from elections. We will focus on these markets because, in contrast to some other types of markets run on elections, these can be judged for accuracy against the final election outcomes.

A substantial number of participants in election stock markets exhibit less than rational behavior. Data from the 1988 Iowa Presidential Stock Market (Forsythe et al., 1992), the 1993 UBC Election Stock Market (Forsythe et al., 1995) and other election stock markets demonstrate that, on average, traders tend to exhibit some substantial judgement biases. In particular, traders' preferences over parties or candidates tend to color their perceptions, creating a 'wishful thinking' effect. This arises because traders who prefer a particular party are overly optimistic about their preferred party's likely success in the election and they interpret news more favorably with respect to that party. Thus, they make larger investments (number of shares or proportion of funds) in their preferred party's contracts than traders who prefer other parties. Non-rational behavior can also arise from 'mistakes,' actions that are not financially optimal for any set of beliefs—biased or not. For example, Oliven and Rietz (1995) show that there were substantial arbitrage opportunities in the 1992 Iowa Political Market which could not have arisen with fully rational traders. Through their individual bids and asks, traders often left fairly significant sums of money on the table for others to pick up. Nonetheless, in spite of this evidence, each of these markets predicted the corresponding election outcome extremely well.

Together, these observations leave us with something of a conundrum. How can a market accurately measure an asset's value when traders behave irrationally? One answer is that relatively few 'marginal' traders who are influential in setting market prices are all that is needed for the Hayek hypothesis to succeed. Unfortunately, we have no direct test of this conjecture due to the nature of the field experiments conducted. However, a combination of field and laboratory experiments may help us better understand these apparent biases and mistakes, and their effects on asset prices.

To begin the process of using field and laboratory experiments jointly to study markets, we review several laboratory experiments (Rietz, 1998) that reproduce mistakes similar to

those found in the election stock markets (Oliven and Rietz, 1995). These mistakes actually appear more prevalent, larger and more enduring in the laboratory than in the field. We also report the results of a new experimental market session that reproduces the 'wishful thinking' effect found in election stock markets. Absolute price changes lend credence to the idea that traders are biased in placing higher probabilities on events that they would prefer to occur. Surprisingly, in spite of mistakes and biases, relative prices correspond quite closely to predictions on average in these laboratory markets, implying that all prices are distorted by the same proportion.

We conclude with discussions of the similarities and differences between laboratory and field experiment designs and results. In some areas, laboratory results mirror field results. However, in other areas, it appears that current laboratory experiments do not lead to the same phenomena observed in the field. We argue that there are important differences between the laboratory and the field that might explain the divergence in results.

2. The design of the Iowa election stock markets

The Iowa Presidential Stock Market (now the Iowa Electronic Markets or IEM), was developed and first operated for the 1988 U.S. presidential election. Since then, it has been used in dozens of elections.[2] While the IEM now operates markets on events other than elections, here we focus on the large, North American election stock markets we have conducted. Berg et al. (1997a) and the IEM website (www.biz.uiowa.edu/iem) discuss the structure of these markets in detail. Here, we will highlight important aspects of these markets.

Though customized to accommodate the different political systems of the various countries, the basic features of these markets are identical. The IEM is a real-money futures market operated over the Internet or local networks as a research and teaching project. Participants invest their own funds, buy and sell listed contracts, and bear the risk of losing money as well as earning profits. The method of issuing contracts to the market and of making final payoffs after the election is such that the IEM itself cannot realize a profit or loss. All monies collected from traders are redistributed to traders and no commissions or transactions fees are charged, nor is interest paid on cash balances.

Contracts in the markets we study here represent promises to pay a liquidation value after the election based upon the fraction of seats won (in 'seats' markets) or the fraction of the popular vote received (in 'popular vote' markets). Typically, such a contract on Party A in a seats market would pay off after the election at a price equal to $1 times the fraction of seats in the legislature won by Party A.[3] So, for example, if Party A won 30 percent of the seats, Party A contracts would be liquidated at 30 cents. In a popular vote market, the

[2] It has been exported to support markets in a number of other countries including Australia, Canada, Denamark, Finland, France Germany, The Netherlands, Sweden and Turkey.

[3] The formula has been different in some cases, most obviously when the market is operating in a country that does not use dollars. However, the principles are the same.

liquidation values equal the percent of the votes received by the associated candidates.[4] With liquidation values determined this way, it is easy to see that, if markets are efficient, the current price at which any particular contract is trading during the market is a prediction about the fraction of seats (or votes, depending on the market) that traders expect to be won by that party. We focus on these particular markets here because, with this payoff structure, we can easily judge market level efficiency by comparing market prices to election results. The presidential election markets in the US have been of the 'popular vote'-type while 'seats' markets have been operated on elections for the U.S. House of Representatives and Senate, the Canadian House of Commons and others.

A new trader gets access to the market by filling out an application form and filing it with the market organizers. With her application she makes an initial investment which is placed in her cash account.[5] These are the funds on which she may draw to buy contracts. Purchases will result in transfers of contracts to her portfolio and the deductions of the requisite funds from the cash account. Analogously, sales of contracts will result in the transfer of the contracts from her portfolio to that of the buyer and the crediting of her cash account for the amount of the purchase.

The market is fully computerized and traders access it through the Internet. Trading is completely anonymous. The program keeps track of every trader's portfolio and cash balances, outstanding bids and asks, and all transactions. Every relevant action is recorded in an audit trail file.

Contracts are placed into circulation when traders purchase bundles of contracts, termed 'unit portfolios,' for a set price of $1 (in American or Canadian funds as the case may be). Each unit portfolio consists of one contract for each candidate (or party) in the market. Each contract will payoff $1 times the fraction of votes (seats) acquired by that candidate (party).[6] Vote (seat) shares are determined in a (commonly known) manner to insure that they sum to 100 percent (see note 3). Thus, the dollar investment in a unit portfolio held to liquidation will have to return a dollar to the trader, no more and no less. The IEM also stands ready to repurchase unit portfolios for $1 each at any time. The combination of this issuing and liquidation method leaves the predicted price of individual contracts unchanged as new shares are issued. Once a trader has purchased some number of unit portfolios, she can unbundle the contracts immediately and trade them individually. She can also buy individual contracts from other traders.

Contracts are traded using telnet in a continuous electronic double auction with queues.[7] Traders can issue bids to buy or asks to sell (limit orders), or they can trade at the best

[4] To insure that the contract liquidation values sum to $1, we either include a contract for all candidates not specifically listed (typically called 'Rest of Field') or payoffs are calculated as the percentage of votes received by all listed candidates.

[5] In some markets there are upper and lower limits on these investments.

[6] For example, in a Presidential Vote-share Market with two candidates, A and B, the unit portfolio would consist of one each of the two contracts, Contract A and Contract B. After the official election returns are determined, each contract is paid $1 times the respective candidates share of the two-party vote. Thus, unit portfolios are a zero–risk zero return investment.

[7] Telnet operates through a continuous connection and thus, unlike web-based trading, there are no delays for updating screens.

outstanding bid or ask (market orders). Just as with traditional limit orders, IEM limit orders require defined prices, quantities and expiration dates.[8]

The IEM program provides traders with a considerable amount of information in real time for traders to use when making choices. First, traders have access to all their own private account information: what contracts they own, what outstanding bid and ask orders they have out, what their cash balances are, and what transactions they have completed. Also, traders can access market information that includes the current high bid and low ask and the last transaction price, as well as summaries of past trading activity in the market.

An important point worth stressing here is that IEM markets are not polls. The markets do not require that traders reveal anything at all about their own personal preferences for candidates or parties through their trading. (Though we ask for some of this information in voluntary, on-line surveys, which are not released to other market participants.) Traders will succeed if they predict better than other traders how the population as a whole will vote on election day. In theory, at least, their personal preferences are irrelevant and we do not need, or necessarily want, a large pool of traders who are representative of the voting population. The market is much more like a large panel of motivated, interested experts than it is an opinion poll.

2.1. Past successes of IEM markets

In general, IEM markets have been remarkably successful at predicting election outcomes, particularly the larger markets run in North America. The markets often provide much more accurate predictions of vote shares than those provided by the final pre-election opinion polls. While these markets have been the largest and possibly the most accurate, many smaller markets run on elections in individual states and in Europe also predicted quite well.

In Fig. 1, we present a scatter diagram plotting the predicted election outcomes (from normalized share prices just before the election) and actual final values (from the actual election outcomes) for 106 contracts in 20 different markets.[9] Results from the 1988, 1992 and 1996 U.S. presidential elections are highlighted along with those from the 1993

[8] Outstanding bid and ask orders are held in queues ordered first by price and then by time entered (on a first-in-first-out basis). Traders are not required to maintain an inventory to cover all of their outstanding asks, nor must they maintain cash to cover all their outstanding bids. However, if a bid or ask reaches the top of its queue, the trader must be able to trade at least one unit or the offer is ruled infeasible and cancelled. In general, a bid or ask remains in the queue until it is withdrawn by the trader, it expires, it reaches the top of its queue and is found to be infeasible, or it reaches the top of the queue and is accepted by some other trader. Purchases on margin and uncovered short sales are not permitted. However, traders can construct synthetic short positions by buying a portfolio consisting of all candidates and selling the share corresponding to the candidate the trader wishes to short. This results in the same payoffs as a short position in that candidate, but is fully covered in the sense that whatever the outcome, the trader will not owe the market additional funds.

[9] The final predictions here are created by taking the final prices and 'normalizing' them by dividing by the sum of all the prices. If the last trade prices sum to one exactly, this normalization changes nothing. However, they may not sum exactly to one because of trades that occurred at different times. In this event, the normalization creates predictions that do sum to one. Forsythe et al. (1995) chose not to normalize the Canadian Federal election results in this way for in their paper. Without the normalization the average absolute error was 0.53%.

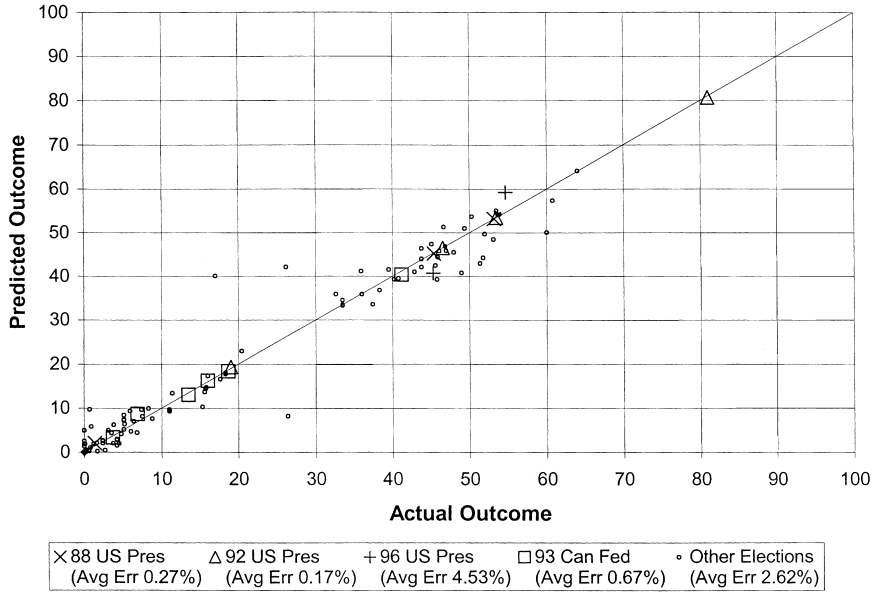

Fig. 1. Market predicted versus actual election outcomes.

Canadian federal election. A prediction that matches exactly the outcome would lie on the 45° line of this graph. The reader will notice how close to the 45° line most of these observations lie. [10] The average absolute prediction error is 2.39 percent. In the four large North American election markets (highlighted), the average absolute error was only 1.75 percent. Thus, the IEM markets are generally very accurate, with the large North American markets proving exceptionally accurate.

Berg et al. (1997b) show how efficient U.S. vote share markets have been overall. They study factors contributing to efficiency in 16 markets. They find that three variables can explain most of the variation in predictive accuracy across markets (with an adjusted R^2 of 93%). These variables are: (1) the number of contract-types traded in a market (corresponding roughly to the number of major candidates), (2) the pre-election market volumes, and (3) differences in election eve (weighted) market bid and ask queues. A larger number of contract-types (i.e. more parties or candidates) tends to increase the error as do large queue imbalances. Higher dollar volumes are associated with smaller errors.

Neither the results from Berg et al. (1997b) nor the data in Fig. 1 would seem to support the finding of any obvious biases on an aggregate scale. Nor is there a tendency for traders to overprice low-value contracts or underprice high value contracts as might have been predicted by, for example, prospect theory or the theory Potters and Wit (1995) developed

[10] The three obvious outliers come from under-predicting Tsongas' vote share in the 1992 Illinois and Michigan primary markets and over-predicting Brown's vote share in the 1992 Michigan primary market. See Berg et al. (1997a).

for these markets. [11] Instead, prices seem correct on average. And the errors, which are quite small on average, seem independent of whether the predicted prices were high or low. In the next sections, we show that this accuracy arises in spite of clear biases and sub-optimal individual trader behavior.

3. Systematic biases and mistakes

While, at the market level, political stock markets generally predict election outcomes quite well, the data they generate also provide valuable information about decision making on an individual level. Here we assemble data from a number of markets to look at two kinds of departures from perfectly rational decision making on the part of individual traders: 'judgement biases' that can lead traders to make optimizing decisions with biased subjective probabilities on uncertain events; and 'mistakes,' decisions that are financially sub-optimal relative to *any* set of beliefs and that represent a lack of understanding or care.

3.1. Wish fulfillment

The tendency to overestimate the probability of desirable events has been observed in many different contexts. Here we use the term 'wish fulfillment' which we borrow from political science, but psychologists have long documented many related phenomena which they have described as 'optimism' (or sometimes 'unrealistic optimism' or 'optimistic bias') and 'wishful thinking.' [12] Such biases come under a broader set of 'self-serving' biases and are of the form that one's thinking, and therefore her actions, are motivated by what she wants to be true. [13] In the examples that interest us, political scientists have observed a tendency for survey respondents to overestimate their preferred candidate's or party's chances of victory. [14] They have also produced substantial evidence that voters view information about their preferred candidate or party more favorably than voters who prefer an alternative candidate or party. [15]

[11] Potters and Wit (1995) argue that the combination of differences of opinion and the budget constraint in these markets will serve to drive up prices for low value contracts and drive down prices of high value contracts. The observation depends on the difference in abilities of traders to drive up and drive down prices. For example, a trader with $10 cash can purchase 100 contracts at $0.10 if he or she believes that the price should be higher than $0.10. To sell these contracts, a trader who believes that the value is less than $0.10 would be able to afford to sell 11 contracts. (The trader would have to purchase 10 unit portfolios at $1 each to sell the first 10 contracts. Then, with the $1 resulting from the sales, he or she could buy another unit portfolio and sell one more contract.) Thus, given the same wealth and budget constraints, traders who wish to bid up low priced contracts have more 'power' than those wishing to bid the price down. An analogous effect works for high priced contracts in the opposite direction.

[12] For examples, see Irwin (1944, 1953), Marks (1951), Crandall et al. (1955), Slovic (1966), Slovic and Lichtenstein (1968), Babad and Katz (1991) and Reece and Matthews (1993).

[13] See Rabin's (1996) survey.

[14] For examples, see Bartels (1987), Lazarsfeld et al. (1944), Carroll (1978), Brown (1982), Granberg and Brent (1983), Uhlaner and Grofman (1986), Brady and Johnston (1987) and Johnston et al. (1992).

[15] For examples, see Brody and Page (1972), Page and Brody (1972), Markus and Converse (1979) and Page and Jones (1979).

As trading in an IEM election market requires constant decision making under uncertainty and because we can survey our traders about their views and preferences, it is a natural vehicle to explore these issues further. In this paper, we use data collected from several markets to determine the extent to which IEM traders are subject to the biases familiar in the psychology and political science literature. To the extent that they are, we ask how this affects market outcomes.

However, it is possible that wishful thinking leads to biased judgements and affects the decision making of some individuals *without* affecting market prices. We will see if this appears true by studying individual decision making. We look for evidence supporting two particular reasons that wish fulfillment may arise here by drawing on data from the traders' market holdings, from the records of their trading activity and from answers provided by a number of traders to surveys during the campaigns. Among other things, these polls ask traders about their political preferences for the candidates or parties involved in the elections. We use these data to determine if traders were systematically biased in favor of their preferred parties and candidates. [16]

We will investigate two psychological effects that contribute to wishful thinking as observed in existing political science research. First we look for evidence of what the social psychology literature refers to as 'the false consensus effect.' This effect involves the tendency of individuals to overestimate the extent to which their views are shared by others in the population. [17] In the present context this effect would amount to a trader overestimating the likely success of the party she personally favors. Second, we investigate a bias recognized in the psychology literature as the 'assimilation–contrast effect.' [18] This is the tendency of an individual's personal preferences about some event to lead her to an overly optimistic interpretation of information relating to that event. The need for cognitive consistency leads individuals to interpret good news about a favorite item more favorably than they should otherwise. They also interpret good news about a less favored item less favorably than they otherwise should. [19] Both of these psychological effects contribute to a 'wishful thinking' effect as observed in political science research. In the IEM markets there are always a number of significant campaign events that traders must interpret. Using data from two IEM markets, we look to see how traders' perceptions of which candidate won the leaders' debates were related to their own political preferences and the extent to which this influenced their trading behavior.

3.2. The false consensus effect

In the context of these markets, the false consensus effect would lead a trader to believe that her preferences among the various candidates or parties are more representative of the larger population of voters than is indeed the case. Due to this overly optimistic view, the trader would anticipate a larger share of the popular vote for her preferred candidate

[16] Traders were not compelled to answer the survey questions and many chose not to, so the samples are smaller than the corresponding sets of all traders.
[17] For examples, see, Kelley and Stahleski (1970), Dawes et al. (1977), Ross et al. (1977) and Brown (1982).
[18] For examples, see Sherif and Hovland (1961) and Parducci and Marshall (1962).
[19] See Isan and Patrick (1983) and Johnson and Tversky (1983).

Table 1
Relation between preference and expectation in U.S. presidential elections[a]

Year	Democrat/ Republican	Respondents intending to vote Democratic who expect Democrat to win (%)	Respondents intending to vote Republican who expect Republican to win (%)	Who prefer and expect the same candidate to win (%)
1996	Clinton/Dole	99.1	25.6	72
1992	Clinton/Bush	87.5	69.0	80
1988	Dukakis/Bush	51.7	94.2	74
1984	Mondale/Reagan	28.8	99.0	71
1980	Carter/Reagan	87.0	80.4	84
1976	Carter/Ford	84.2	80.6	82
1972	McGovern/Nixon	24.7	99.6	77
1968	Humphrey/Nixon	62.5	95.4	81
1964	Johnson/Goldwater	98.6	30.5	81
1960	Kennedy/Nixon	78.4	84.2	81
1956	Stevenson/Eisenhower	54.6	97.6	80
1952	Stevenson/Eisenhower	81.4	85.9	84

[a]Source: Granberg and Brent (1983) who use survey data collected by the Survey Research Center/Center for Political Studies of the University of Michigan. Entries for 1984, 1988 and 1992 were obtained from correspondence with Professor Granberg. Entries for 1996 were constructed directly from Survey Research Center/Center for Political Studies American National Election Survey data.

or party. In turn, this would lead her to demand more contracts associated with her preferred party/candidate (and supply fewer contracts) at each price than traders who prefer other parties/candidates. In this context the false consensus effect shifts the position of an individual's excess demand function for contracts. [20]

As indicated above, political scientists have observed this effect in survey research. Consider, for example, the results of Granberg and Brent (1983) reported in Table 1. Respondents were asked for which candidate they intended to vote and which candidate they expected to win. The results are striking: for example, at one point in the 1980 U.S. presidential election campaign, more than 80 percent of those intending to vote Democratic expected Jimmy Carter to win while 87 percent of those intending to vote Republican expected Ronald Reagan to win. Economists might be reluctant to accept these effects as meaningful, given that these are just surveys and respondents have nothing at stake. IEM markets provide a way to assess the degree of judgement bias in which the subjects reveal their beliefs about outcomes through their trading activity.

We have two ways to use the IEM market data to test for the false consensus effect as exhibited by IEM traders. The first involves looking at the contract holdings of traders at market closing and seeing if they tend to hold more of the shares of their preferred party or candidate than does the average trader. For another set of markets we have data on trading

[20] A referee made the interesting suggestion that the same behavior could be caused by cognitive dissonance and the desire to be internally consistent. Using Rabin's (1994) model, the dissonance caused by the inconsistency between one's planned behavior (i.e. who one planned to vote for) and beliefs (i.e. who one expects to win) can be lessened by changing either one's planned behavior or one's beliefs. Since this theory leads to a prediction that planned behavior should closely align with beliefs, it is observationally equivalent to the false consensus effect in context. We will use the false consensus interpretation and label in the text.

Table 2
Preferences and unbalanced portfolio holdings for the 1993 Canadian House of Commons market

Percent of unbalanced portfolio held by	In the following contracts					
	BQ	LIB	NDP	PC	REF	OT
All traders	18.0%	50.2%	4.9%	9.7%	16.7%	0.5%
Those who prefer column contract	0.0%	62.5%	17.4%	31.5%	35.8%	13.5%
Correlation	−0.590	0.339[a]	0.228[a]	0.270[a]	0.504[a]	0.078[a]
(*p*-value, one-tailed *t*-test)	(0.268)	(0.000)	(0.008)	(0.000)	(0.000)	(0.000)
Number who prefer	1	33	17	30	25	9

[a] Significant at the 95% level of confidence.

activity by party of preference. These data can be used to construct a second test based on immediate actions (trading) instead of just their results (final holdings).

Preferences and holdings. The first test involves several rather straightforward steps. We begin by defining an 'unbalanced portfolio' for each trader. A trader's unbalanced portfolio at closing is just the number of shares of each contract held after all unit portfolios have been withdrawn from the trader's account. [21] This adjustment recognizes that unit portfolios are equivalent to cash and only the unbalanced portion of a trader's holdings reveals any information.

Given market closing prices of all contracts, we compute the value of each trader's unbalanced portfolio and the percentage share of that value being held in each contract. By a similar procedure we can determine the aggregate value of unbalanced holdings in the entire market and the percentage shares attributable to each party's contracts. [22] Finally, by comparing an individual trader's unbalanced holdings to those of the market (i.e. of the average trader), we can look for patterns influenced by personal preferences.

Table 2 reports the results of these comparisons for the 1993 Canadian House of Commons Market. Here, the party identifiers are: BQ–Bloc Québécois, LIB–Liberal Party, NDP–New Democratic Party, PC–Progressive Conservative Party, REF–Reform Party and OT–Other Parties and Candidates. To understand how to read these columns, consider the middle column headed 'NDP.' The 4.9 percent share indicates that 4.9 percent of the value of all unbalanced holdings in the House of Commons Market (a market based on the fraction of seats won in the House by each party) held by all traders was in NDP contracts. These values are determined using prices at market closing. Below that, we can see that among traders who indicated a preference for the New Democratic Party, NDP contracts amounted to 17.4 percent of the value of unbalanced holdings. [23] The last number in the column

[21] For example, suppose a trader holds 10 shares of contracts in Party A, 7 of B and 8 of C and that these are the only three parties being traded in the market. Then it would be possible to withdraw seven unit portfolios, leaving an unbalanced portfolio of 3 of A and 1 of C.

[22] As there are always the same number of contracts issued in all parties, if the final market prices summed to exactly one, the shares attributable to the parties' contracts in the market as a whole would be equivalent to those prices (since each is multiplied by the same quantity). However, the final prices did not exactly sum to one in the Canadian market studied here.

[23] In fact traders were asked their political preferences in three separate surveys through the campaign. The last survey was done during the week preceding the election and those are the responses used here. When a trader did not answer the last preference survey but did answer a previous survey, the most recent response was used for that trader.

reveals that there were 17 traders who indicated a preference for the New Democratic Party and who had some unbalanced holdings of contracts in the House of Commons Market.

In the House of Commons Market there is indeed evidence of judgement bias. With the exception of the one Bloc Québécois supporter, the other groups had larger holdings of their preferred parties than did the market generally (all of the correlations except the Bloc Québécois are significant at the 95 percent level of confidence according to *t*-tests). In terms of ratios, these results are strongest for those preferring the New Democratic and Progressive Conservative Parties: these traders have portfolio shares of their preferred party more than three times larger than the market average. [24]

To assess the statistical significance of the differences in the House of Commons Market, Forsythe et al. (1996) estimated a series of equations in which the share of unbalanced holdings in a particular party's contracts was regressed on a constant and a dummy variable that equaled one if the trader preferred that party. The sample for these regressions included only those traders for whom we had preference information and who had some unbalanced holdings. The full results are given in their paper, but the primary results are quite clear. For all contracts except Bloc Québécois and Other (for which there are very few supporters in the sample), an individual trader's personal preference had a positive and statistically significant effect (at the 5% level or better according to *t*-tests) on the holding of contracts related to the preferred party.

Preferences and trading activity. For some other IEM markets, we have data on trading activity by preferences. We report here how trader preferences affect average net purchases across active days. [25,26] Since every transaction requires a buyer and a seller, we would expect biased traders to, on balance, buy more shares of their preferred candidate or party and sell more shares of candidates and parties they do not prefer. Table 3 presents results from the 1988 U.S. presidential election market for all traders and for marginal versus non-marginal traders (discussed in detail later). [27] The numbers in Panel A indicate that supporters of George Bush on an average active trading day bought (on net) 1.12 Bush shares and sold (on net) 2.26 Dukakis shares. Dukakis supporters, on the other hand, bought on average 2.01 shares of Dukakis on each active trading day and sold 1.59 shares of Bush. [28]

[24] Similar patterns hold for the Canadian Popular Vote Market, but sample sizes are quite small.

[25] The use of the term 'active' days is necessary when examining our 1988 U.S. presidential election market. All traders had University of Iowa affiliations and few of them could connect and trade from off-campus locations. For this reason, weekends and periods when classes were not in session generally were periods when no trade took place. We use the term active days because we have eliminated those days from our analysis.

[26] There are a number of alternative ways to measure trading activity. In Forsythe et al. (1992), we looked at five alternatives and they all led to the same conclusion. Here we report just one of these statistics: average net purchases across active days.

[27] Forsythe et al. (1993) also present similar data for the 1990 Iowa Senate election market.

[28] The reader will note that, while we used portfolio values when analyzing the Canadian market, we are using only the number of shares here. In a close, two-candidate race, like Bush–Dukakis, the prices (approximately) cancel out when computing value-weighted portfolios. The same cannot be said for a multi-party race, such as the Canadian election reported above, where prices across different parties' contracts varied widely.

Table 3
Average net purchases of shares by preferences of traders 1988 U.S. Presidential Election market

Average of net purchases across active days of shares of	Candidate preferred		
	Bush (SE)	Dukakis (SE)	*t*-test statistic
Panel A: All traders			
Bush	1.12	−1.59	1.85[a]
	(1.11)	(0.96)	(df = 170)
Dukakis	−2.26	2.01	−3.43[b]
	(0.90)	(0.86)	(df = 170)
Panel B: Marginal traders from October 18 through November 7[c]			
Bush	0.10	−0.49	0.24
	(1.80)	(1.39)	(df = 104)
Dukakis	−2.21	0.26	−1.07
	(1.43)	(1.83)	(df = 104)
Panel C: Non-marginal traders from October 18 through November 7[d]			
Bush	1.18	−1.49	3.18[b]
	(0.56)	(0.63)	(df = 151)
Dukakis	−0.84	2.11	−3.55[b]
	(0.53)	(0.65)	(df = 151)

[a] Significant at the 90% level of confidence.
[b] Significant at the 95% level of confidence.
[c] 'Marginal traders' are those who submit limit orders at prices close to the market price.
[d] 'Non-marginal traders' are those who (1) are inactive, (2) submit only limit orders at prices far away from the market price, or (3) submit only market orders.

Taken together, these results demonstrate that this form of wish fulfillment is present in these markets. On average, traders act as if their own beliefs are representative of the population and trade accordingly. [29]

3.3. The assimilation–contrast effect

In both the 1988 U.S. presidential election and the 1993 Canadian Federal Election Markets, traders who watched the leaders' debates were asked their assessments of the relative performance of the participants. Positive correlations between party preferences and the evaluation of the preferred party leaders' performances would constitute evidence for assimilation–contrast effects. Taken alone, this evidence is unconvincing since, in their role as survey respondents, traders had nothing at stake. However, we demonstrate below that the traders, on average, make trades consistent with these responses and, in so doing, they back up their responses with cash.

The 1988 U.S. presidential debates. Traders in the 1988 Presidential Election Market clearly differed in their assessments of which candidate won the three debates, and dif-

[29] An alternative explanation might perhaps be that traders state beliefs that rationalize their trading behavior. However, since the observations on their trading behavior occurred after they had been asked about their preferences, we would contend that this suggests that this alternative explanation is less likely to be true.

Table 4
Perceived debate outcome in the 1988 U.S. Presidential market versus preferred candidate before debate (number of observations in parentheses)

Debate	Presidential preference[a]	Perceived winner[a]			
		Bush or Quayle	Dukakis or Bentsen	Same or no opinion	$\chi^2(2)$-stat (p-value)
1	Bush	47.6% (20)	19.0% (8)	33.3% (14)	
					27.006[c] (0.000)
	Dukakis	4.8% (2)	69.0% (29)	26.2% (11)	
2[b]	Bush	28.6% (14)	51.0% (25)	20.4% (10)	
					54.243[c] (0.000)
	Dukakis	0.0% (0)	94.1% (48)	5.9% (3)	
3	Bush	78.2% (43)	3.6% (2)	18.2% (10)	
					81.841[c] (0.000)
	Dukakis	19.6% (9)	41.3% (19)	39.1% (18)	

[a] According to telephone polls of traders.
[b] Vice-presidential debate.
[c] Significant at the 95% level of confidence.

fered according to their personal preferences in a manner consistent with the hypothesized assimilation–contrast effect. Table 4 documents this. For example, 80.4 percent of the Michael Dukakis supporters thought Dukakis did at least as well as George Bush in the third debate, while only 21.8 percent of the Bush supporters felt this way. [30]

Table 5 reports the changes in the holdings of traders after each of the three debates according to which candidate they believed won the debate. Note that after all three debates those who felt Bush won the debate moved more of their portfolio to Bush shares while those who felt Dukakis won reduced the fraction of Bush shares in their portfolio (thus, increasing their fraction of Dukakis shares).

The 1993 Canadian party leaders' debate. In 1993 there were two leaders' debates, one in English and the other in French. While too few of the traders watched the televised French language debate, a large enough number watched the English language debate the next evening to permit us to compare traders' political preferences to their perceptions of which leader 'won' the debate. Table 6 shows that, on average, more traders felt that the

[30] In a political context, polling data has been used to show that among respondents who have already indicated they intend to vote for a particular candidate, these intentions serve as a screen influencing their judgements of which candidate 'won' a debate (Sigelman and Sigelman, 1984).

Table 5
Two-day change in portfolio composition by perceived debate outcome in the 1988 U.S. Presidential market as measured by change in fraction of major candidate shares held in Bush stock

Debate	Candidate thought to have won[a]		
	Bush (SE) obs.	Dukakis (SE) obs.	*t*-stat (dof)
1	4.8 (2.3) 22	−4.0 (2.2) 41	14.899[c] (61)
2[b]	1.5 (1.6) 14	−1.6 (0.7) 83	12.167[c] (94)
3	2.2 (3.4) 56	−0.9 (1.0) 22	4.191[c] (76)

[a] According to telephone polls of traders.
[b] Vice-presidential debate.
[c] Significant at the 95% level of confidence.

Table 6
Political preferences and evaluations of the debate in the 1993 Canadian Federal Election

Leader who won[a]	Party preferred[a]						Row total number
	LIB	NDP	PC	REF	OT	Undecided	
BQ	0.0%	0.0%	7.1%	11.1%	0.0%	0.0%	3
LIB	**44.4%**	28.6%	7.1%	5.6%	0.0%	25.0%	16
NDP	16.7%	**50.0%**	0.0%	0.0%	0.0%	12.5%	11
PC	0.0%	0.0%	50.0%	0.0%	50.0%	25.0%	10
REF	38.9%	14.3%	35.7%	**83.3%**	0.0%	12.5%	30
No opinion	0.0%	7.1%	0.0%	0.0%	50.0**%**	25.0%	4
Column total (%)	100.0%	100.0%	99.9%	100.0%	100.0%	100.0%	
Column total (no.)	18	14	14	18	2	8	74

[a] According to on-line polls of traders.

leader of the Reform Party had won. Nevertheless, the patterns of responses suggest some judgement bias here as well. As is clear from the size of the numbers in bold type relative to the others in their columns, supporters of a party were more likely to report their view that 'their' leader won than to report that any other leader won. This effect is significant at the 95 percent level of confidence (with an overall Pearson's $\chi^2(25) = 81.711$, $p = 0.000$).

To determine whether these assessments really matter we look to see if traders' market behavior was consistent with their reported perceptions of who won the debate. We do this using the 2-day [31] change in each trader's contract holdings of the party whose leader they thought won the debate. If traders act on their views of the debate, we should see them increase their holdings (relative to other traders) of the contracts of the party whose leader

[31] This time period runs from the moment the debate began (5:30 p.m. PDT, October 4) to midnight October 6, which gave traders 2 full days to adjust their portfolios.

Table 7
Two-day changes in holdings after the debate for the 1993 Canadian House of Commons market

Holdings before and after	Perceived winner[a]				
	BQ	LIB	NDP	PC	REF
Holdings of perceived winner before	3.8%	9.7%	12.6%	11.8%	80.1%
Holdings of perceived winner after	7.0%	12.8%	19.4%	11.3%	88.7%
Change	3.2	3.1	6.8	−0.5	8.6
Correlation of change in party holdings and	0.3570[b]	0.1508	0.2833[b]	−0.1614	0.3543[b]
whether that party was the perceived winner (*p*-value)	(0.008)	(0.271)	(0.036)	(0.239)	(0.000)
Number of traders with unbalanced holdings before and after	3	13	9	6	24

[a] According to on-line polls of traders.
[b] Significant at the 95% level of confidence according to *t*-tests on the estimated correlation coefficients.

they saw as performing best. The results of this comparison are presented in Table 7 for holdings in the House of Commons Market.

Table 7 shows the share of unbalanced holdings of each contract before and after the debate. For example, the first number reveals that those who felt that the BQ leader 'won' the debate held 3.8 percent of all the BQ shares held in unbalanced portfolios just before the debate. The number below this reports that those holdings went up to 7.0 percent after the debate. The table also shows the correlations between change in holdings of a party and whether a trader thought that party won the debate. The correlations are significantly positive for three of the five parties and not significantly different from zero for the other two (with one positive and one negative point estimate). We conclude that this provides some evidence that traders did respond to their own evaluations of the leaders' performances in the English language debate. [32]

3.4. Mistakes

Oliven and Rietz (1995) provide direct evidence of sub-optimal trader behavior in the 1992 U.S. Presidential Market. They analyze data from the 1992 vote share market because of the liquidity and accuracy of this particular market. They identify two distinct types of obviously sub-optimal behavior. In contrast to the biases discussed above, these actions cannot be economically justified for any set of beliefs, biased or not.

First, Oliven and Rietz identify 'price taking violations' of the law of one price. These violations occur when a trader accepts a transaction price that is clearly not in the trader's best interest. Specifically, there are always two ways for a trader to execute any particular transaction in an election stock market. If a trader executes a purchase transaction (by accepting an ask) at a price higher than the lowest available price, the trader is giving up a sure profit and the transaction is identified as a price taking violation. Similarly, if a trader executes a sale transaction (by accepting a bid) at a price lower than the highest available,

[32] Again, similar patterns arose for the Canadian Popular Vote Market, but the sample size was quite small.

the transaction is identified as a price taking violation.[33] The actions are called 'price taking' because the traders are trading at prices set by the bids and asks submitted by other traders.

Second, Oliven and Rietz identify 'market making violations' of no-arbitrage pricing restrictions. These violations occur when a trader submits an at-the-market bid or ask that is clearly not in the trader's best interest. Again, there are always two ways to offer a particular transaction in an election stock market. If a trader submits a new best bid when there is an immediately available lower price for the same purchase transaction, the trader is giving up a sure profit and the bid is identified as a market making violation. Similarly, if a trader submits a new best ask when there is an immediately available higher price for the same sale transaction, the ask is identified as a market making violation.[34] In these cases, the trader is actually creating an arbitrage opportunity that any other trader could exploit profitably without risk. Note that, since transactions occur at either the best bid or best ask, submitting new best bids and asks actively sets available transactions prices. Thus, they are called 'market making' actions.

Violations were surprisingly frequent. In data covering 17 July through 2 November 1992 (the day before the election), traders violated these weak forms of rationality in 17 percent of the market making and price taking orders overall.[35] Oliven and Rietz also define the 'size' of each violation as the difference between the price committed to and the best available price times the number of contracts actually traded (for price taking violations) or the number of contracts ordered (for market making violations).[36] This gives the losses incurred because of the violation. The average violation in the time period studied resulted in losses of $0.097. Price taking violations occurred in 34.4 percent of the price taking orders with an average loss of $0.104. Market making violations occurred in 5.80 percent of the market making orders with an average loss of $0.071. Thus, both types of violations occur frequently for traders in a long duration, extremely active and extremely accurate election stock market.

[33] To illustrate this type of violation, consider the 1992 U.S. Presidential market. A unit portfolio consisted of one share each of R.BU (Bush) and D.CL (Clinton). Each paid $1 times the fraction of the two-party vote received by the respective candidates. A price-taking trader who wanted to effectively sell an R.BU contract could sell the R.BU contract immediately at the best bid for R.BU, say $0.500. Alternatively, the trader could purchase a D.CL contract at the best ask for D.CL, say $0.400 and sell the resulting unit portfolio back to the exchange for $1. The next transaction is identical: one less R.BU. However, the net prices differ. In this case, the trader accepting the R.BU bid receives $0.500, the trader accepting the D.CL ask and selling the portfolio receives $0.600. These two transactions are both immediately available and, since traders who hold cash in a trading account do not even have to actually make the portfolio sale, they are typically accomplished with the same amount of effort.

[34] To illustrate this type of violation, consider again the 1992 U.S. Presidential market. A market-making trader who wants to offer an R.BU contract for sale could submit an ask, say $0.500, for R.BU and, if the order is executed, receive the asking price for R.BU. Alternatively, that trader could immediately execute the transaction by purchasing a D.CL at its best ask, say $0.400, and selling a unit portfolio back to the exchange for $1. The net trade is identical: one less R.BU. The net sale price for this immediate execution through selling the D.CL contract is $0.600. Thus, by submitting the ask on R.BU, the trader would be giving up sure profits and be subject to execution risk. Note that this also creates an arbitrage opportunity. The sum of the asks would be $0.900, creating a $0.100 arbitrage opportunity for other traders.

[35] 17 July was the date that the IEM reduced the number of contracts in the Democratic and Republican vote share markets to two contracts, making the arbitrage restrictions and pricing violations much more apparent.

[36] The violation size is recorded in as conservative a manner as possible. See Oliven and Rietz (1995) for details.

Oliven and Rietz identify several factors that contribute to these violations. They also discuss how markets characterized by such violations may, nevertheless, display the pricing efficiency that characterizes typical election stock markets. They studied various factors associated with the order, the trader and the state of the market. Their results suggest that error rates fall with more experienced, more educated and more knowledgeable market making traders, who submit larger orders to markets with smaller spreads and lower overall volumes. The primary driver seems to be the choice of role: market-making or price-taking. Given the key importance of role, Oliven and Rietz study what types of traders choose to be market makers and what types choose to be price takers. They show that more experienced traders and more highly educated traders are more likely to be market makers. Traders with higher reported income levels tend to be price takers as do those who reported a religious affiliation. Finally, men were more likely to be market makers while women were more likely to be price takers.

4. Why do these markets work in spite of individual biases and errors?

4.1. IEM 'marginal trader' effect

Forsythe et al. (1992) give evidence that the success of their 1988 market was consistent with a 'marginal trader hypothesis.' The motivation for this hypothesis is the simple argument that the results on judgment bias refer to the average trader, while prices are determined by the *marginal* trader. While this hypothesis has a long tradition in economics, it has been rarely tested.

For this market, they operationalized this hypothesis by distinguishing between 'limit orders'—offers entered into the queues without resulting in immediate trades—and 'market orders'—offers which amount to acceptance of an outstanding ask or bid and lead to an immediate exchange. The traders identified as 'marginal traders' are those who submit limit orders at prices close to the market price, while traders not identified as marginal are (1) those who are inactive, (2) those who submit only limit orders at prices far away from the market price, or (3) those who submit only market orders.

They examine a period during which prices were very stable. For this market, it was the period shortly after the third, and last, presidential debate: 18 October through 7 November. Over this period, a trader was identified as marginal if there were at least 3 days during which he or she either (1) had a bid or an ask in the queue at the end of the day at a price within 2 cents of the price of the last trade of the day, or (2) had a bid or ask accepted by a another trader sometime during the day. This precise definition of marginal trader is somewhat arbitrary; alternative definitions that use a few more or a few less days of market activity to classify a trader as a marginal trader lead to essentially the same results.

Defined in this way, there was little difference in the demographic make -up between marginal traders and other participants in the market with one exception: gender. Marginal traders were exclusively male and there is no obvious reason for this. Another major difference between marginal traders and other participants is the total investment made in the market. Marginal traders on average invested more than twice the level of non-marginal

traders. They also traded more shares and were active in the market on more days. Marginal traders also earned significantly higher returns.

The pattern of returns suggests that their definition of marginal traders does pick out individuals whose judgment about political events was not clouded. To examine the issue of judgment bias directly, refer to the analysis for marginal and non-marginal traders in Table 3. Panels B and C reveal that marginal traders show no indication of a judgment bias in their transactions. The difference between the average net purchases of stock in the two major candidates is small and statistically insignificant for both Dukakis and Bush supporters. In contrast, the remaining traders exhibit evidence of a large and statistically significant judgment bias: non-marginal Bush supporters purchase significantly more shares of Bush stock, while non-marginal Dukakis supporters purchase significantly less.

4.2. IEM market maker versus price taker effect

Oliven and Rietz (1995) provide more evidence on how prices can be set in a relatively rational manner while individual traders frequently violate rationality. In so doing, they further refine the notion of marginal traders to include a subset of the 'marginal' traders defined in the Forsythe et al. (1992) study. In particular, they separate the traders who set bid and ask prices at the top of their respective queues (market makers) from those who accept others' prices (price takers). This definition of market makers eliminates those traders who set prices 'near' the top of the queue who were included in the definition of marginal traders in the earlier study. [37]

Oliven and Rietz (1995) show that market makers are far less prone to errors than price takers. The error rate for price takers is nearly six times the error rate for market makers. Thus, traders who set prices appear far more rational than those who accept prices. Further, they show that more active, experienced and educated traders and those who report they are knowledgeable about financial markets are less subject to errors and that fewer errors are associated with larger orders on average. These traders, who tend to be market makers, are able to drive prices to efficient levels while profiting from the mistakes of more error-prone traders, who tend to be price takers.

5. Laboratory experiments

In the last section we showed that, while Election Stock Markets are generally efficient in predicting outcomes, individual traders often display behaviors that would seem to impair the market's ability to aggregate information efficiently. We cited evidence that suggests that a small core of more rational traders at or near the market can drive market prices to efficient levels. Here, we show how laboratory experiments can help us explore these phenomena. Specifically, we review evidence from Rietz (1998) showing that arbitrage

[37] The major reason a broader definition for marginal traders was used in the Forsythe et al. (1992) study was to have a sufficient number of traders defined this way. This 1988 market had only 192 traders in total and the definition used identified 22 traders as marginal. The Oliven and Rietz (1995) study examined the 1992 Presidential Market in which 1,102 traders participated.

violations appear consistently in laboratory experiments. These violations are similar to those that appear in election stock markets, but are actually more frequent and robust. Nevertheless, relative prices in laboratory markets accord closely with predictions in spite of these arbitrage violations. Finally, in a new laboratory session, we show that we can create observable price effects by endowing traders with specific preferences for state outcomes. This is a basic form of the wish fulfillment effect. This demonstrates that this effect can be observed in the more controlled laboratory environment. A complete laboratory analysis of such effects, price formation and market efficiency is beyond the scope of this paper. However, we hope the sessions presented here show how a combination of small laboratory experiments and larger field experiments can complement each other in studying these issues.

5.1. Market design and general results

Rietz (1998) conducted oral double auctions markets that mirror the election stock markets in several important ways. Here, we will discuss the highlights of the market design. See Rietz (1998) for details. In each period, subjects traded two state-contingent claims ('Green Certificates' and 'Blue Certificates') simultaneously. [38] In addition to the usual double auction rules, subjects could accept bids or offers in both certificates simultaneously. Using a commonly known random mechanism, Blue certificates liquidated for 1000 'francs' (the experimental currency unit) with a probability of 0.3 in each period, while Green certificates expired worthless. Green certificates liquidated at 1000 'francs' with a probability of 0.7 in each period, while Blue certificates expired worthless. Similar to the election stock markets, the design insured that the aggregate payoffs in each period were independent of the state. In contrast to election stock markets, the subjects did not purchase unit portfolios. Instead, they received initial endowments of cash and either 6 Blue and 2 Green certificates or 2 Green and 6 Blue certificates. Traders alternated between these two endowments in each period.

The parallel with an election stock market should be clear. The Blue and Green certificates are analogous to candidates or parties. At the end of a trading period we observe which contract 'wins' the election where either the Green certificate (sic candidate) receives 100 percent of the vote or the Blue certificate receives 100 percent of the vote. We can use this structure because, in contrast to election stock markets, we know the true state probabilities here, allowing us to evaluate price efficiency. In addition to sharp price predictions, the binary payoff structure should also increase saliency for participants. [39] As in the election stock markets, the aggregate supply of each certificate is the same.

Arbitrage Opportunities. Recall that Oliven and Rietz (1995) show arbitrage violations in election stock markets. Similarly, Rietz (1998) shows that traders regularly forego certain

[38] The experimental currency was converted to dollars at the fixed and known exchange rate of $0.0005 per unit. This makes the minimum increment of currency equal to a half mil. The minimum unit in the political markets ranged form 1 mil to 1 cent.

[39] In the stylized laboratory markets conducted, only these extremes were used. Clearly, other possible payoff structures are possible, corresponding to other 'vote shares' as long as the sum of the payoffs on the two certificates adds to 1000. Readers will note that laboratory structure parallels the 'winner takes all' election stock market contracts. (These contracts pay of $1 if the candidate or party wins the election.)

Table 8
Summary of arbitrage opportunities

Session:	OPIS-1	OPIS-2	OPIS-3	OPIW-1
Bids, asks and acceptances:	404	729	531	929
Bids and asks	265	535	328	635
(% of bids, asks and acceptances)	(65.59)	(73.39)	(61.77)	(68.35)
Both blue and green bids outstanding	33	181	79	140
(% of bids and asks)	(12.45)	(33.83)	(24.09)	(22.05)
Blue plus green bids exceed 1000	31	133	66	140
(% of both outstanding)	(93.94)	(73.48)	(83.54)	(100.0)
Average profit available	177.42	180.90	97.72	274.64
Both blue and green offers outstanding	28	58	55	138
(% of bids & asks)	(10.57)	(10.84)	(16.77)	(21.73)
Blue plus green offers less than 1000	0	0	0	0
(% of both outstanding)	(0.00)	(0.00)	(0.00)	(0.00)
Average profit available	0	0	0	0

arbitrage profits in these laboratory markets. Since a unit portfolio of one Green certificate and one Blue certificate is risk-free, arbitrage opportunities are clearly defined and easily exploitable. Whenever a bid for each certificate-type is outstanding and they sum to more than 1000, an arbitrage violation has occurred. Any subject can exploit the arbitrage opportunity without risk by simply accepting both bids. [40] Similarly, subjects can exploit profitable arbitrage opportunities whenever the asks sum to less than 1000. [41]

Rietz (1998) discusses how often such opportunities arose and how profitable they were on average. They are amazingly frequent and robust. Table 8 shows the arbitrage opportunities that arose in the experiment run for this paper (OPIW-1, discussed in detail later) and a treatment in Rietz (1998) that effectively allowed short sales (labeled OPIS, discussed in detail in Rietz, 1998). [42] For example, for OPIS-1, Table 8 shows the following: There were 404 bids, asks or acceptances submitted (Row 1). Of these, 265 or 65 percent were new bids and asks (Row 2). [43] Of the bids and asks, 33 (12.5%) occur when there are bids outstanding in both markets (Row 3) and 28 (10.57%) occur when there are asks outstanding in both markets (Row 5). Of the 33 times bids were outstanding in both markets, 31 (93.94%) resulted in profitable arbitrage opportunities that would have returned an average of 177.42 francs in profit (Row 4). Of the 28 times asks were outstanding in both markets, none resulted in profitable arbitrage opportunities (Row 6).

[40] For example, if the two bids summed to 1200 francs, the subject could accept both bids and, if necessary, purchase the needed certificates later for 1000 francs. This results in a sure profit of 200 francs because the portfolio sold has a certain payoff of 1000 francs.

[41] For example, if the two asks summed to 800 francs, the subject could accept both asks. This results in a sure profit of 200 francs because the portfolio purchased has a certain payoff of 1000 francs.

[42] In these sessions, as in the political stock markets, traders could effectively buy unit portfolios from the experimenter for 1000 each and sell off single securities and/or portfolios in the market to other traders. Rietz (1998) reports on a number of other treatments that all lead to similar results.

[43] Note acceptances eliminate existing arbitrage opportunities.

Arbitrage opportunities arose an average of 92.5 times per session for average available profits of just over 200 francs. Across all of these sessions, only one subject exploited an opportunity one time. That subject stopped the market to ask the experimenter publically how much she would profit from in this transaction. She did not repeat it, nor did other traders follow it with similar trades.

These results are similar in composition to the mistakes found in election stock markets: traders frequently leave money on the table through violations of arbitrage restrictions. However, they are quite different in size and persistence than those observed in election stock markets. In the election markets, arbitrage opportunities are present, but they do not persist and they seemingly have little, if any, effect on market performance. In the laboratory sessions, they not only persist, but they cause absolute prices to be greatly inaccurate. In the conclusions, we will discuss possible reasons for these differences.

Market prices. The prevalent arbitrage opportunities are associated with general overpricing. The average absolute transaction prices for the laboratory market sessions are shown in Fig. 2. (Here, the heavy solid lines represent the predictions. The light solid and dashed lines represent average trade prices and summed average trade prices. The dotted lines give two-standard-deviation confidence intervals.) For periods in which both Blue and Green certificates were traded, the sum of their prices exceeded 1000 francs (the cost of a unit portfolio) in all but two periods and they fell generally in the 1200–1300 range. Interestingly, Rietz (1998) also finds that normalized (i.e. relative) prices in his markets are very close to the predicted prices in spite of the persistent bias in absolute prices. [44]

5.2. Basic wish fulfillment treatment

As mentioned earlier, the election market data are replete with evidence of various kinds of wish fulfillment on the part of traders. Recall that wish fulfillment occurs when individuals overweight the likelihood of an event that is favorable to them. Here, we report on a new experiment (labeled OPIW-1) designed to look at wish fulfillment in a market setting in its starkest form.

The environment is identical to that of Rietz (1998) with the addition that subjects are given a direct preference for a state. This is done by giving them the opportunity to win a monetary prize at the end of a trading period. Whether they win a prize depends only on the state and does not depend on how they have traded. In the first period of trading, no trader receives a prize. In the second period of trading, all traders receive a prize of 4000 francs ($2) if the Blue state occurs and, in the third trading period, all traders receive a 4000 franc prize if the Green state occurs. Every succeeding sequence of three periods proceeds in this manner. Traders are told only their prize for each period and not the distribution of prizes for other traders. [45]

Wish fulfillment and prices. Using additional prizes conditional on state outcomes, we have allowed for the possibility of a one-sided effect in the laboratory environment. With

[44] Rietz (1998) uses the same normalization as used to make IEM predictions; dividing a certificate's price by the sum of the prices of both certificates.

[45] Using this method to induce preferences in each subject for the outcome is isomorphic to having traders who prefer which candidate wins in our election stock markets.

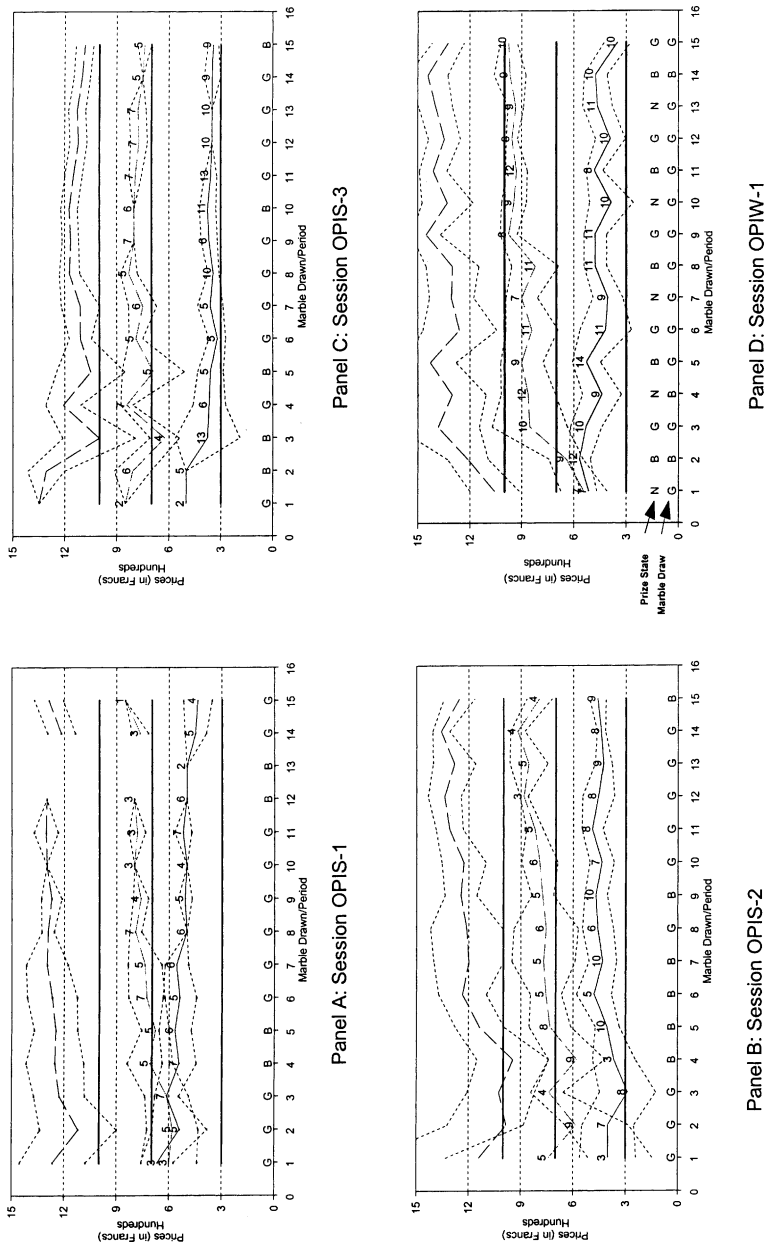

Fig. 2. Average absolute certificate prices.

perfectly rational, risk-neutral traders, the null hypothesis is that the behavior observed in all periods should be the same (and should also coincide with that reported in Rietz, 1998). Alternatively, if subjects are risk-averse, the standard diversification argument from finance would suggest that they should try to diversify away all of this state risk by holding more certificates of the other type. For example, in periods in which they receive a prize in the Blue state, traders should bid up the price of Green certificates, and consequently bid down the price of Blue certificates as they attempt to diversify away the risk. Finally, wish fulfillment gives the opposite prediction: traders will bid up the price of the certificate that corresponds to the (preferred) state corresponding to the prize. [46] Here we ask whether prices moved up or down between no-prize periods and periods with a prize.

The results from the prize state/absolute price change correspondence can be inferred from Fig. 2. When the Blue state resulted in an additional prize, average absolute Blue prices increased five out of five times from the previous non-prize period. Similarly, when the Green state resulted in an additional prize average absolute Green prices increased four out of five times. Thus, prizes were associated with increased average absolute prices for the corresponding contingent claims in nine out of ten cases. The average gain was 85 francs. In the other case, the average absolute price dropped by 22 francs. In contrast, in periods with no prize, average absolute prices fell six out of eight times from the previous period in which a prize was associated with a particular state. This difference is significant at the 99.5 percent level of confidence (with a Pearson's $\chi^2(1)$ of 7.9013). [47]

These results show that, when the whole market would prefer one outcome over another, prices reflect this preference with the claim associated with the preferred outcome being bid up. This is consistent with wish fulfillment and inconsistent with hedging arguments. Traders in election stock markets do not all prefer a single candidate or party. Instead, their preferences are distributed across candidates and some traders may have no strong preferences. While our current laboratory experiment does not allow us to study such a distribution of preferences, we can aggregate across laboratory periods. There are an equal number of no-prize, Green prize and Blue prize periods in the experiment. Table 9 shows

[46] Risk-seeking preferences may be an alternative explanation of generally high asset prices for most priced gambles. However, it is not clear why risk-seeking individuals will choose to let arbitrage violations stand in these experiments. Further, in this design all risk-seeking traders should trade a 'corner' with all their holdings in one certificate-type. Such 'corner' outcomes seldom occurred here. Further, the stability of prices argues against risk-seeking traders as a cause. (Results in James and Isaac, 1998, suggest that risk-seeking preferences will destabilize markets.)

[47] Corresponding results for average normalized prices show a similar effect. Using the no-prize periods as benchmarks, prizes were associated with increased average relative prices for the corresponding contingent claims in only six out of ten cases. The average of the six gains was 53 francs. In the other cases, the average loss was 10 francs. Going from periods with prizes to those with no prize, average relative prices fell five out of eight times. However, normalization creates a confounding effect. Normalized price movements between any two periods are affected by absolute price movements in both claims between these periods. In the case of Blue prize-to-no-prize comparisons and no-prize-to-Green prize comparisons, both Blue and Green prices change two times. A better comparison may be between subsequent states in which the prize switches from Blue to Green or from Green to Blue. When going from Blue prize to Green prize states, normalized Blue prices fell and normalized Green prices rose in five out of five cases. When going form Green to Blue prize states, normalized Green prices fell and normalized Blue prices rose in three out of four cases. Thus, the wish fulfillment prediction was correct in eight out of nine cases. This is significantly different from random price movements at the 0.998 level of confidence according to a binomial test.

Table 9
Average absolute and normalized average prices in OPIW1

Prize state	Average absolute prices		Normalized average prices	
	Blue	Green	Blue	Green
None	438.04	848.89	340.38	659.62
Blue	485.28	875.83	356.59	643.41
Green	453.57	898.64	335.43	664.57
Overall	462.42	873.24	346.21	653.79

the average blue and green prices across no prize, Blue prize, Green prize and all periods. It also shows the resulting normalized prices. For both Blue and Green claims, the highest absolute and normalized prices occurred in the associated prize periods. The lowest absolute prices were in the no-prize periods. The lowest normalized prices were in the prize periods associated with the other claim. Note that the overall average normalized prices are very close to the no-prize period averages and both are relatively close to the predictions. Thus, averaging across-trader preferences may wash out some effects of wish fulfillment in prices.

Wish fulfillment and trading behavior. As discussed above, wish fulfillment appears to affect trading activity and portfolio holdings in election stock markets. The evidence arises from comparisons across traders who prefer the different parties in the elections. Presumably, a similar effect may be found in laboratory markets if some of the traders received prizes in each of the two states. However, in this laboratory session, if any traders received a prize in a state, all traders received that prize in that state in that period. Thus, we cannot compare across traders who received prizes in different states. However, we can see whether the endowment, the prize state and/or the prize state/endowment interaction affects transactions and final trader holdings. We will measure differences in final portfolio holdings by the level of risk held. Since risk arises from holding unbalanced portfolios, this is equivalent to using the number of unbalanced certificates held. [48]

Table 10 shows the dependence between the level of relative (to their own average) end-of-period risk held by each trader and three variables: (1) the endowment, [49] (2) the bonus prize state (if any) and (3) the alignment between the endowment and bonus prize state (if any). (There are two endowments in the OPIS sessions and six possible combinations in the OPIW session.) Half of the traders in the OPIS sessions (15 out of 30) displayed consistent endowment effects. However, only two traders in OPIW-1 had effects related purely to endowments. Three traders seemed affected significantly by the prize state and five traders seemed affected significantly by the endowment/prize state alignment. Overall, only one trader (Number 2) seemed unaffected by all of these variables. Simple correlation and ANOVA results bear this out in a model relating end-of-period risk held to these three variables and the individual trader ($R^2 = 0.7386$, adjusted $R^2 = 0.6104$ and a model F-statistic of 5.77 with 49 degrees of freedom). Across all subjects in all sessions, the

[48] Balanced portfolios are risk-free. At equilibrium prices, the mean absolute deviation in portfolio value for one unbalanced Blue certificate equals the mean absolute deviation for one unbalanced Green certificate: 420 francs. For each additional unbalanced certificate held, the mean absolute deviation goes up by another 420 francs. Thus, for all traders-risk, measured by mean absolute deviation, is proportional to the number of unbalanced certificates held.

[49] Recall, traders alternated between 6 Blue and 2 Green certificate and 2 Blue and 6 Green certificate endowments.

Table 10
χ^2-tests of independence of the subjects' initial endowment, prize state and initial endowment/prize state alignment and displayed relative risk preference indicator variables[a]

Subject	Session and item					
	OPIS-1	OPIS-2	OPIS-3	OPIW-1		
	Endowment	Endowment	Endowment	Endowment	Prize State	Endowment/prize state alignment
1	4.4196	8.0405[c]	0.0446	0.5788	2.1429	11.7857[c]
2	0.5357	5.5293[c]	3.2334[b]	1.7267	3.7500	0.1339
3	1.6071	0.0244	3.3482[b]	0.0765	6.9643[c]	11.9866[c]
4	1.7267	0.5357	8.7500[c]	0.0765	2.1429	4.8214[b]
5	4.2857[c]	0.5788	3.2334[b]	3.2334[b]	0.5357	0.1339
6	3.2334[b]	4.4196	3.3482[b]	0.5788	6.9643[c]	4.4196
7	5.6250[c]	8.5714[c]	0.0446	2.6451	7.0500	14.2188[c]
8	1.7267	6.5625[c]	0.5788	2.7551	5.1429	11.5714[c]
9	0.1339	1.6071	3.2813[b]	0.5788	8.5714[c]	2.4107
10	0.7143	3.2334[a]	11.4844[c]	3.2334[b]	0.5357	1.1384
No. Sit.:	3	5	7	2	3	5

[a] Indicator variable defined by comparing end-of-period certificate holdings to average end-of-period certificate holdings. −1 = lower-than-average risk held, 0 = average risk held, 1 = higher-than-average risk held. Depending on whether subjects ever held 'average risk'portfolios, the χ^2-statistic will either have 1 (if that subject did not hold some actual average risk portfolios) or 2 (if that subject did) degrees of freedom.
[b] Significant at the 90% level of confidence.
[c] Significant at the 95% level of confidence.

correlation between the expected value of the endowed portfolio and the level of end-of-period risk borne is 0.2314. Across all subjects in OPIW-1, this correlation is 0.1959. Both are significant at conventional (95%) levels according to *t*-tests on the estimated correlation coefficients.

5.3. Summary of laboratory evidence

In summary, the experimental results show the following. Arbitrage violations are easily produced in the laboratory. They are relatively larger and more persistent than those found in field markets. Some aspects of wishful thinking can also be reproduced in the laboratory. Subjects bid up absolute prices of contingent claims that will pay off in a state for which subjects have an induced preference. Further, subjects' end-of-market certificate holdings often appear affected by their endowments, induced preferences over states or combinations of both.

6. Conclusions

We have reviewed a body of work that demonstrates that election stock markets perform quite well in spite of substantial evidence that, on average, traders behave far less rationally than theory would seem to demand. We have argued that this is due to the fact that, in markets,

Table 11
Differences between field and laboratory markets

Item	Field markets	Laboratory markets
Mechanism	Anonymous	Face-to-face
	Multiple unit	Single unit
	Computerized double auctions w/durable queues	Oral double auctions w/no queues
Duration	3 to 24 months	15, 5 to 7 minute periods
Size	'Large' (>200) number of traders	10 traders
Trader population	Traders self-selected into/out of the market	Traders recruited for an 'economics experiment'
Payments	Traders invested own money	Traders earned experimenter's money

it is the marginal trader, and not the average trader, that matters in the price determination process. Using data from two of our markets, we have presented evidence that is consistent with this argument.

We have also begun to see whether we can isolate arbitrage opportunities and wish fulfillment biases in the laboratory for further analysis. Results from Rietz (1998) have proved quite encouraging along these lines. A new session reported here provides more evidence that this can be done. We observe both arbitrage violations and apparent wish fulfillment effects on prices. Laboratory traders make 'mistakes' just as election stock market traders do. They can also be influenced by a vested interest in one outcome.

However, while these phenomena carry over to the lab to some degree, they seem to manifest themselves in different ways. For example, Rietz (1998) finds that arbitrage opportunities are not only prevalent, but that they also persist throughout the experiment and lead to absolute price levels that are far from predictions. (Interestingly though, relative prices are quite close to predictions when traders are not endowed with preferences for particular states.) In the laboratory experiments we run, wish fulfillment manifests itself in prices, not holdings. How can such similarities and differences be explained?

The answer to this would seemingly lie in the many ways that the election stock markets differ from Rietz's laboratory environment. For example, traders in the laboratory began with unequal endowments of Blue and Green certificates. In the election stock markets, traders acquired contracts to trade only by buying unit portfolios consisting of one contract in each candidate or party. Rietz suggests that endowment effects may give rise to his results.[50] Since traders in election stock markets are not endowed with contracts, but deposit cash and purchase positions themselves instead, endowment-related effects may differ across the laboratory and election stock markets. This is only one difference between election stock markets and the laboratory environment which might explain the differences in behavior. Others are given in Table 11. We hope to look at some of these alternative explanations in future studies.

[50] In theory, risk-averse traders should diversify away all risk by holding equal numbers of both certificates regardless of their initial endowment of certificates. Risk-seeking traders should trade until they are short sale constrained in one asset-type and hold as much of the other asset-type as they can. This should hold regardless of the initial endowment. Consistent with an endowment effect, Rietz (1998) finds that traders seldom diversify completely nor do they take on as much risk as possible.

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