Trading incentives and market behaviour in experimental prediction markets[#]

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Abstract

In this paper we analyse two political stock markets, conducted on occasion of a local election in Germany. Both markets were designed almost identically, except for the need to invest real money in one market, while the other was implemented with virtual currency. This data set gives us the unique opportunity to analyse the impact of the incentive structure on market performance, volatility and forecast quality as well as traders' behaviour in a large experimental market. We find that prices in the real-money market are significantly more stable and safer against manipulation attempts. However, the forecasting ability of both markets was almost the same, showing that markets are very robust to changes in the incentive structure.

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I Introduction

The relevance of trading incentives for the proper functioning of and pricing in markets is quite undisputable. As Adam Smith recognized in the Wealth of the Nations, ”*it is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love*.” The driving force behind trading activity as well as economic exchange is the wish of agents to increase their personal wealth.

Experimental prediction markets make use of this basic economic principle. They give traders the opportunity to take advantage of their private information by trading virtual contracts reflecting outcomes of uncertain future events. By revealing their willingness to pay through their market orders, the private information of all traders is collected and aggregated in market prices. According to Hayek (1945), those market prices are more than just the averaged opinions of all traders. He states, they are the best existing estimator for the real prices of the contracts, as “*might have been arrived at by one single mind possessing all the information which is in fact dispersed among all the people involved in the process*” (Hayek 1945, p. 526). With Adam Smith’s idea on our minds, it should become clear that experimental prediction markets can not claim to produce information-efficient prices in the sense of Hayek. As the amount of money that traders can invest in an experimental market is usually small, the incentive of pure economic self-interest is missing in those markets. Due to legal problems and additional costs, many experimental prediction markets are even conducted with complete absence of real money investment. Instead, prices for the best traders and a public ranking are supposed to assure rational trading. One basic principle of experimental economics is to reduce the complexity of the real situation and isolate those factors being subject of research. Hence, the aim of this article is to show how changing the incentive structure will change the market performance and the forecasting-ability of prediction markets. The question whether or to what degree the incentive design affects the subject's decisions was topic of several laboratory experiments delivering inconclusive results:[1] Tversky and Edwards (1966), Grether and Plott (1979) as well as Kahnemann and Tversky (1983) contributed experiments with and without monetary rewards, concluding that results correspond. On the other hand, Binswanger (1981), Wolf and Pohlman (1983) as well as Kachelmeier and Shehata (1991) show, that risk preferences of subjects change with monetary incentives.

For field experiments, the variety of publications is much smaller. To our information, there is only one study which analyses the impact of real-money-investment on experimental markets. Servan-Schreiber et al. (2004) compare the predictive accuracy of two experimental markets, where traders can bet on the outcomes of the NFL American Football League. They conclude that real-money-investment does not enhance the predictive accuracy of those markets. Unfortunately, this study only analyses data concerning the predictive accuracy while deeper insights into market microstructure and performance are not possible.

The reason why present literature does not cover extensive comparisons of experimental prediction markets may be that every experimental market has several unique institutional conditions, so it is almost impossible to compare two markets with each other. To shed light on this much disputed and imminently important question we conducted two political stock markets with very similar designs for one election. The main difference was, that one market was run with real money, while the other was without the investment of own money.

The remainder of the paper is structured as follows: In the next chapter we will give a brief overview on the history, the scientific interest and the challenges experimental prediction markets face today. Next, we discuss the theoretical implications of different incentive designs and develop hypotheses accordingly. In chapter 4 we will briefly explain the market design of both PSM's. Next we look at findings from the comparison of the markets. Chapter 6 concludes the paper.

[1] For an extensive literature discussion, compare Smith and Walker (2000)

II History, scientific interest and challenges of experimental prediction markets

The first applications, seizing upon the idea of an experimental prediction market, were political stock markets (PSM). They were introduced in 1988, when a team of economists at the University of Iowa set up a market to predict the outcome of the U.S. presidential election (Forsythe et al., 1992). Experimental economics was then still very young and the Iowa political prediction markets and their followers in other countries would soon become the largest experiments with up to 30.000 participants in one market (Huber, 2001).

Based on Hayeks (1945) idea of markets as tools for information aggregation, the creators of the first PSMs assumed, that markets could deliver good election forecasts, if people were allowed to freely trade contracts (called 'stocks') written on the vote-shares of candidates or parties (vote-share markets) or their chances of winning the election (winner-takes-all markets). Prices in PSMs are derived by participants setting limit or market orders for the different stocks. Whenever a trader believes a party is valued too high, she may sell the share; if she considers a party undervalued she will buy it. The equilibrium prices should then be a good forecast for the election outcome, reflecting the aggregate opinions of all traders[2].

The idea worked perfectly already in the first attempt in 1988: the market delivered a forecast for the election result which was six times more precise than the best forecast based on traditional opinion research (Forsythe et al., 1992). At the following U.S. presidential elections in 1992 a bigger market which achieved more attention was organized by the same team of scientists. Again the forecast from the PSM and the election result differed by only 0.2 percent, while the best poll had a mean absolute error (MAE)[3] of 1.2 percent (Jacobsen et

[2] For a more detailed introduction to experimental prediction markets, comp. Huber (2001).

[3] The MAE is the most common measure of prediction accuracy for political stock markets. It is derived by adding up all the absolute differences of stock price and election result and dividing this by the number of

al., 2000). Subsequent markets and PSMs in other countries sometimes produced good results, but especially in Europe the predictions were often not better than those of polls (Brüggelambert, 1999; Schmidt, 2001).

For social scientists, forecasting uncertain future events is not the only purpose of conducting experimental prediction markets. These virtual markets can also be used as field experiments in experimental economics. One of the central questions in economics and finance is, whether, or to what extent, markets are efficient. This is basically a question of how good markets are in aggregating and disseminating information. However, it is difficult to give an answer to this question with tests in real markets, as the 'real' intrinsic value of most assets is never revealed. In experimental prediction markets however, the intrinsic value of all contracts is revealed on the day the uncertain event (e.g. the election) takes place. We can therefore test and estimate the ability of those markets to aggregate information.

Regarding the trading mechanism (continuous double-auction-market), the institutional conditions, and the high number of traders taking part in the market, experimental prediction markets provide conditions that are quite similar to those of capital markets. Despite that, research has shown that several factors can (i) affect the forecast ability of those markets and (ii) make it hard to transfer derived results to other, especially financial, markets. Most notably such factors are the number of traders, the number and relative size of parties, the experience of traders with stock markets, manipulation attempts, and the size of real money investment (comp. Jacobsen et al., 2000; Huber, 2001). In this paper we focus on the last point.

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contracts in the market. The exact formula is presented below. A MAE of zero would mean a "perfect" forecast.

III Methodology

Aim of this paper is to analyse the implications of the presence or absence of real money investment on forecasting accuracy, volatility, and other trading variables of experimental prediction markets. We therefore compare data from two political stock markets with almost identical design, the main difference being that one was a real-money market, while the other was run without real money investment.

1 Trading behaviour

In experimental prediction markets where traders do not have to invest real money, irrational trading behaviour can occur for two reasons: according to Brüggelambert (1999), a 'destructive' type of trader may be in the market, generating benefit out of trading behaviour that increases spreads and causes himself losses. His aim is not to have a good trading performance and to generate profits, but to disturb or destroy the experiment. Although our experience with experimental prediction markets did not deliver stong evidence for the existence of this type of trader, no one will deny that the 'game character' of a market without real money investment will sometimes attract traders who only want to test the trading mechanism for fun[4] and do not strive for a good trading performance. The second, probably more common reason for undesirable trading behaviour is manipulation. It occurs because the absence of real money investment allows traders to open several user-accounts without real cost. If the motivation for traders to manipulate the market is to raise their own performance, they will use those irregular accounts for raising bid-ask-spreads and then transfer money to one of their accounts (see Huber, 2001 for details). Another possible reason for manipulation is to take influence on the forecast. For example, in political stock markets, parties which hope for the mobilisation of voters by the bandwagon-effect are interested in a good forecast.

[4] User-polls carried out by the authors showed, that influencing market prices is a reason for trading for almost 25% of all traders (Huber, 2001; Hauser, 2003).

They may use irregular accounts or motivate their members to buy their contracts in order to raise the market prices of their own party (for a good example see Schmidt, 2001).

The introduction of real money reduces both factors: Grether (1981) contributed laboratory experiments on individual decision making, showing that situations he described as “confused behaviour” are reduced by introducing monetary rewards. When real money is required to open an account in a PSM, the cost of manipulating the market are increased significantly.

Both reasons for irrational trading behaviour imply more noise for the market. The destructive trader wants to destroy the market by undermining the soundness of the trading mechanism. Therefore he will take actions that have direct consequences on market prices either by emptying bid-ask-lists or by trading one contract in large numbers.[5] The implications of manipulation are similar; the performance-seeking trader will empty bid-ask-spreads, forecast-manipulators will trade their contract in large numbers. Some models have shown that a decrease of rationality is commonly associated with increasing noise (Black, 1986, Lux/Marchesi, 2000). For experimental prediction markets, Spann and Skiera (2004) have shown that there is a significant negative relationship between the volatility of a contract and the forecast quality. They conclude that low volatility (as a proxy for little noise) of a contract is a good indicator for the rationality and homogeneity of traders’ opinions.

If investors have to put their own money at stake to act in the market it becomes more unlikely that they will take actions that cause them to loose money. This leads to the expectation, that real-money markets should display less destructive and manipulative trading and therefore more stable prices.

Hypothesis 1: Standard deviations of tick-returns, hourly returns and daily returns are significantly lower in real-money markets as compared to no-money-markets.

[5] For more details on this compare for example Hauser (2003).

If destructive and manipulative trading behaviour exists primarily in no-money markets, we should also be able to find evidence in the traders' portfolios. As this kind of trading behaviour implies high losses for those 'irrational' traders, it should also offer profit opportunities for the 'rational' traders. Hence, we expect the final portfolio value of traders to be more divergent in the no-money market than in the real-money market.

Hypothesis 2: The standard deviation of the final portfolio value of all traders is significantly lower in real-money markets as compared to no-money markets.

2 Risk-seeking behaviour

If rational traders do not have to invest real money and if they have the strong motivation to outperform all other traders, it is reasonable to assume that they are willing to take on more risk than traders who invested real money. Hence, those traders will prefer stocks with high volatility. In experimental prediction markets contracts with low nominal prices have systematically higher relative standard deviations (see for example Huber, 2001; Hauser, 2003). This is due to the fact that experimental prediction markets are constructed as zero-sum games, as can be shown by a short example: imagine a market with 2 contracts (YES and NO) where 100 is paid out for the winning contract. If YES rises from 5 to 6, this represents a relative increase of 20%. At the same time, contract NO has to decline from 95 to 94 otherwise there would be an arbitrage opportunity. This decline only represents 1% relative decrease.

In capital markets, risk-aversion leads to a risk-premium, which has to be paid to investors to compensate them for the risk they are taking by buying any asset which is not risk-free. However, if a market consists of risk-seeking traders, we can expect the opposite: traders should be willing to pay a premium for the opportunity to take risk. Hence, small contracts should be overvalued while large contracts should be valued too low in experimental markets where traders do not face financial consequences.

Hypothesis 3: The prices of contracts with a low (high) nominal value are systematically lower (higher) in the real-money market than in the no-money market.

Speculative trading behaviour with a short time horizon produces noise in market prices, as it recommends frequent changes of portfolio positions. In financial markets, "*noise is contrasted with information*" (Black, 1986). The more fluctuation caused by speculative trading, the less fundamental information is reflected in market prices.[6] If market prices of experimental prediction markets contain any information at all, and if speculative trading concentrates on small contracts, we should observe a lower correlation between the two markets for small contracts than for large ones.

Hypothesis 4: The correlation of market prices between both markets is systematically higher for contracts with higher nominal value.

If all the assumptions above hold we can assume that the real-money market delivers a more accurate prediction of the election outcome. Higher volatility of prices and a systematic wrong valuation due to speculative trading should drive prices off the perfect forecast in the market without real money investment.

Hypothesis 5: The forecast in the real-money market will be more precise than the on in the market without real money investment.

[6] Noise in financial markets is not only assumed to destroy the fundamental information reflected in market prices. It is widely accepted that the existence of noise is also essential for trading.

IV Experimental Setup

We present data from two PSMs conducted from Mid-August to Mid-September 2004 for the elections of the regional parliament in the German state of Brandenburg. The two markets were set up almost identically – the only major difference being whether traders invested real money or not.[7]

Both PSMs were vote-share markets with a continuous double auction implemented by the same software company. Therefore not only the trading interface, but also the trading mechanism and the processing of data was exactly the same. Participation was basically open to everyone who had an internet-access. In Wahlprognose (WP) each participant got a starting endowment of 100,000 Wahldollar for free. On Wahl$treet (W$) participants were required to deposit the minimum of € 10 in real money to receive the same 100,000 Wahldollar. The maximum deposit traders were allowed to invest was € 50, providing traders with 500,000 Wahldollar. In this real-money market the starting capital could be lost, but additional cash could also be gained through successful trading.

Apart from the very similar institutional setting the two markets also had comparable numbers of traders and transactions. The trading time was also the same with both markets opening exactly one month before the election and closing on midnight before Election Day. The average starting cash at W$ was about double the amount at WP, which is also reflected in a higher number of shares traded. Table 1 gives an overview over some characteristic numbers of the two markets.

[7] Due to differing wishes by the media partners of the two markets the "other parties" were three separate shares at WP while it was only one share at W$. For our analysis we add up the prices of these three shares to make the data comparable with W$.

Table 1: Wahlprognose and Wahl$treet compared

	real money investment	number of traders	number of transactions	avg. starting cash	shares traded
Wahlprognose	No	111	6,701	100,000	2,090,049
Wahl$treet	Yes	161	7,088	~220,000	3,993,110

V Results and Analysis

Hypothesis 1

In prediction markets we often see risk-seeking behaviour (Huber, 2001; Hauser, 2003), as traders try to reach the top end of the ranking. Traders take high risks – if they are right they have the chance to reach the top-end of the ranking, if they are wrong they loose some money. However, if they loose they do not care how much they loose. This behaviour should be especially pronounced when no real money is involved. Lower risk aversion of traders should be visible in more volatile prices as traders act more aggressively and manipulations can be expected to be more common, as they do not cost anything. In Figure 1 we see, that the volatility of prices (in this case daily average weighted prices[8] of the FDP) was much higher in the no-money market WP than in W$.

[8] Those average prices are calculated by weighting contract prices with their trading volume.

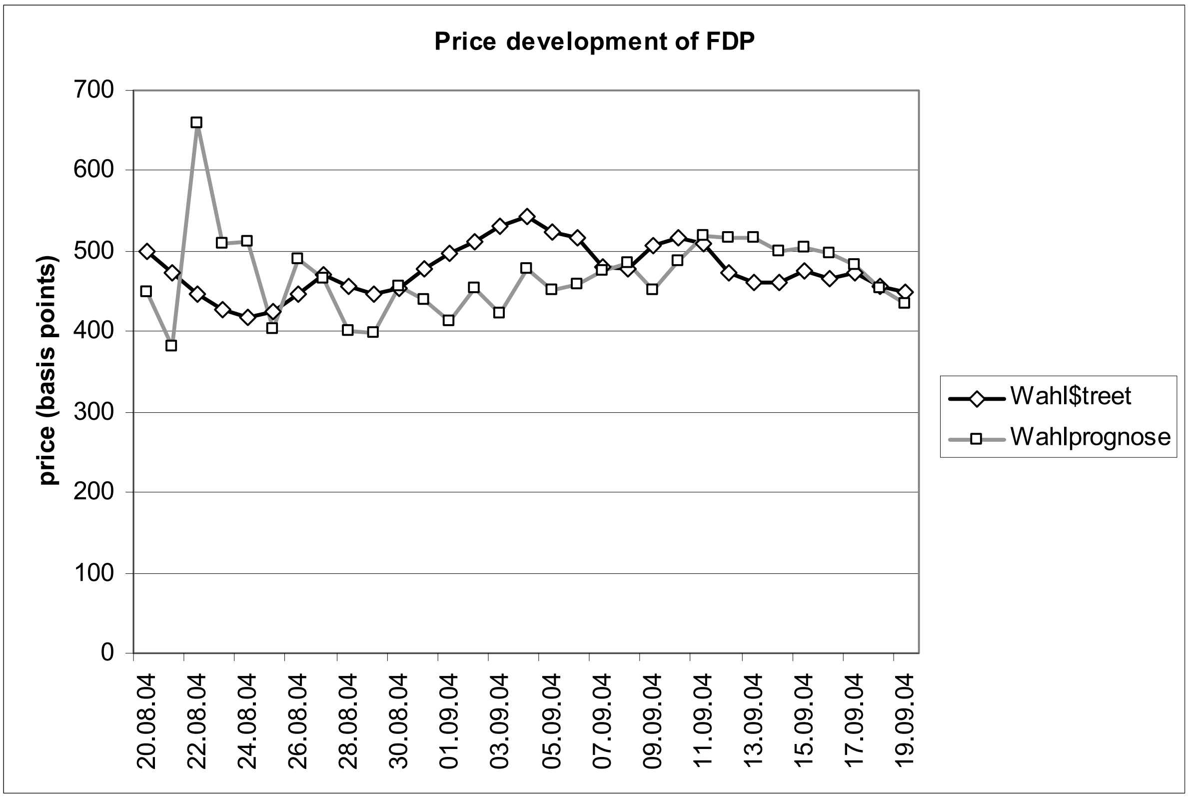

Figure 1: Development of daily average weighted prices for FDP in both markets

Table 2 presents complete data on the volatility in both markets. We calculated tick returns, averaged weighted hourly and daily returns and computed the standard deviations for both markets.[9]

As Table 2 shows, all 15 standard deviations we calculated are at least three times lower in the real-money market W$ than in the no-money-market WP. Note that on average, the standard deviation of WP was more than four times larger than in W$ for all three time horizons. The significant differences of the standard deviations in both markets for all three time horizons (Wilcoxon signed-ranks text, $p<0.05$, $N=5$) give strong support to the argumentation that introducing real money investment reduces irrational trading behaviour as well as price fluctuations.

[9] The OTHERS are excluded in this analysis, as a standard deviation of added-up prices does not make much sense

Table 2: Tick, hourly and daily standard deviations for both markets

	STD tick		**STD hour**		**STD day**	
	W$	**WP**	**W$**	**WP**	**W$**	**WP**
SPD	0.251	1.045	0.203	0.794	0.013	0.046
PDS	0.216	1.308	0.211	0.900	0.018	0.059
CDU	0.353	1.600	0.193	0.917	0.014	0.051
Grüne	0.162	0.484	0.055	0.301	0.019	0.121
FDP	0.167	0.499	0.116	0.364	0.035	0.162
Average	0.230	0.987	0.156	0.655	0.020	0.088

This finding is even more remarkable when we consider that the initial endowment was equal for all traders in WP, but different in W$. In W$ traders' investment varied from €10 to €50 with an average of €22. Some traders therefore had five times the initial endowment of others. Ortner (1996) argues that manipulations, leading to higher volatility, are less likely when traders have the same starting endowment. If one trader has five times more money than others he has five times their market power and can therefore influence prices more strongly. When all traders have the same endowment, as in WP, manipulations become more difficult which should reduce volatility of prices.

Hypothesis 2

To test whether the investment of real money affects the divergence of traders' final portfolio values, we calculated the absolute and relative standard deviation of final portfolio values for all traders in both markets.

Table 3: Absolute and relative standard deviations of final portfolio values for both markets

	number of traders	standard deviation (STD)	avg. endowment at start	STD (% of endowment)
Wahlprognose	111	57,111	100,000	57.1
Wahl$street	161	51,683	~220,000	23.5

On first sight, the standard deviation of traders' portfolio values is only slightly higher in WP. But if we take into account that in the real-money market W$

- the traded volume of contracts was almost twice as high as in WP (Table 1), and that
- the average initial endowment was more than twice as high as in the WP market,

we should actually expect the standard deviation in the W$ market to be significantly higher than in WP. The fact that this is not the case gives strong support to our hypothesis by showing that in the no-money market with less starting capital and a lower trading volume traders had a higher divergence in their final portfolio values. The relative standard deviation is therefore 2.5 times higher in WP than in W$.

Hypothesis 3

In Figure 2 below we see the typical development of the prices of one of the larger parties (here SPD).

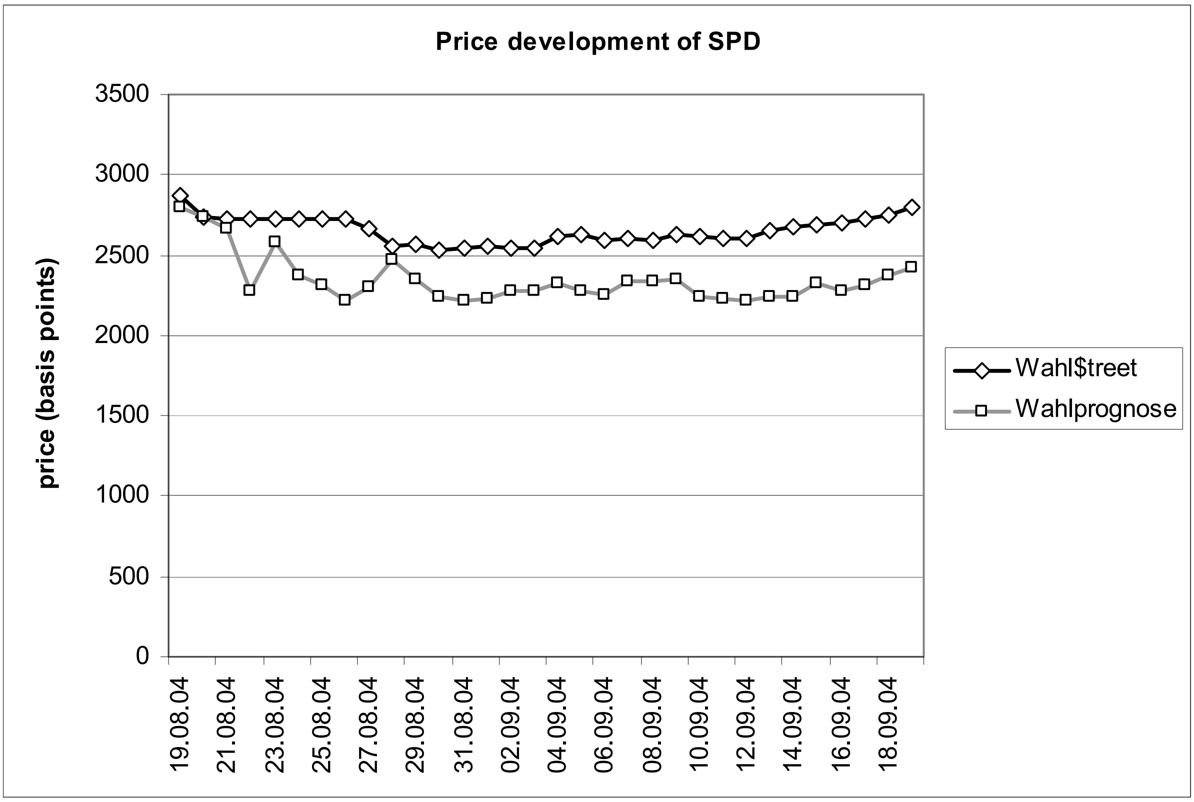

Figure 2: Development of daily average weighted prices for FDP in both markets

Again we note that prices on W$ are more stable than on WP. In addition we see, that they are higher on W$ throughout the whole trading time, which is first evidence supporting our hypothesis

To test the conjecture, we computed the daily average weighted prices for all shares in both markets. Comparing these prices for one stock over both markets with a Wilcoxon signed-ranks-test delivers the following results:

Table 4: Average weighted prices compared

	CDU	**SPD**	**PDS**	**FPD**	**GRUEN**	**OTHER***
average price at W$	24.68	26.54	29.13	4.72	5.64	9.45
average price at WP	23.15	23.61	26.27	4.69	5.28	15.03
Z	4.19	4.84	4.94	0.55	3.29	n.a.
Asymptotic sign. (2-tailed)	0.000	0.000	0.000	0.583	0.001	n.a.

* at W$ this was just one share, while there were three separate shares at WP

We see that the larger CDU, SPD and PDS are all values significantly higher at W$ vs. WP, as we expected. However, the smaller parties FDP and GRUEN are not significantly lower, but approximately the same in both markets. Here the fact that the OTHERS were split into three (small) contracts in WP plays a major role. These three contracts were significantly overvalued (traded 5.5 percent higher at WP vs. W$). Traders obviously speculated mostly in these OTHER shares, which reduced the demand for speculation in GRUEN and FDP at WP, leading to lower than expected values. At W$ those shares were the smallest, implying some speculative premium and leading to higher prices.

In an additional analysis we checked, whether this different valuation in the two markets existed over time. In Table 5 we count on how many of the 32 trading days the average weighted prices are higher on W$ vs. WP.

Table 5: Days that a share is traded higher on W$ vs. WP

	SPD	PDS	CDU	GRUEN	FDP	OTHERS
Wahl$treet higher	30	32	28	28	17	0
Wahlprognose higher	2	0	4	4	15	32

We find the larger stocks (CDU, SPD and PDS) are consistently traded higher on the real-money market W$ than on WP. The same is true for GRUEN, which is also traded higher on W$ most of the time. While FDP is balanced, which both markets leading half of the days, OTHERS are traded higher on WP on al 32 days.

This analysis confirms the findings of Table 4 and the results give support to the intuition that the absence of real money investment affects the risk-preferences of traders: as traders in those markets primarily try to outperform all other traders in order to reach the top of the ranking, they act as risk-seekers and prefer small, speculative stocks. Due to the higher demand for small stocks, those are overvalued which leads to lower prices for larger stocks, as the sum has to be close to 100 at all times to prevent arbitrage opportunities.

Hypothesis 4

Speculative trading behaviour leads to increasing fluctuations of market prices and is contrasted with trading on information. The more speculative trading can be observed, the more fundamental information contained in market prices should be (at least partly) displaced by noise. If this speculative trading – as we assume – concentrates on small contracts, the correlation of market prices between both markets should be lower for small contracts than for larger ones, as the formers' prices are stronger influenced by noise.

Table 6 gives the Pearson correlation between the daily average weighted prices of the parties in the two markets. The results are in favour of our hypothesis: while we find significantly positive correlations for the three larger parties (on the 1% level for the CDU and PDS contract and on the 5% level for the SPD) the smaller parties show significantly lower correlations. For the FDP the correlation is negative with a coefficient of almost -0.3, for GRUEN it is essentially zero.[10]

Table 6: Average weighted daily prices compared

	CDU	SPD	PDS	FPD	GRUEN
Correlation	0.889	0.371	0.537	-0.296	-0.007
Asymptotic sign. (2-tailed)	0.000	0.037	0.002	0.106	0.971

These results support our argumentation by showing, that there is a strong relation between market prices across markets for large contracts, which is supposedly driven by relevant information. Small contracts however, move more independently in different markets, as noise plays a more important role here.

Hypothesis 5

There are several ways to measure the forecasting accuracy of prediction markets; the best known and most widely used being the mean absolute error (MAE).

$$MAE = \frac{\sum_{i=1}^{n} |P_i - R_i|}{n} \qquad (1)$$

n = number of contracts in the market

P_i = market price of contract i

R_i = election result of contract i

[10] The OTHERS are excluded in this analysis, as a correlation of added-up prices does not make much sense

Other measures are the root mean squared error (RMSE), where large deviations are more important, and the mean relative error (MRE), which weights errors in small parties higher.

$$RMSE = \frac{\sum_{i=1}^{n}\left(P_i - R_i\right)^2}{n} \qquad (2)$$

$$MRE = \frac{\sum_{i=1}^{n}\frac{\left|P_i - R_i\right|}{R_i}}{n} \qquad (3)$$

For all three measures a smaller number signifies a better prediction result. Table 7 shows all three measures for our two markets. To get a more comprehensive picture we calculated all measures for two data sets: for the market closing prices (last transactions) and for the average weighted prices of the last trading day. The differences between the two data sets are striking: when we look at closing prices, WP is more accurate in all three measures, but when we look at average prices of the last day, W$ is better in two measures and just slightly behind in the third.

Table 7: Forecasting performance of both markets according to several measures

	MAE (last)*	**MAE (avg.)#**	**RMSE (last)****	**RMSE (avg.)##**	**MRE (last)*****	**MRE (avg.)###**
Wahlprognose	**1.69**	3.15	**4.41**	9.49	**18.72%**	**23.37%**
Wahl$treet	2..33	**2.50**	6.26	**6.80**	24.05%	25.49%

* Mean Absolute Error of market closing prices from election result
# Mean Absolute Error of average weighted prices of the last trading day from election result
** Root Mean Squared Error of market closing prices from election result
Root Mean Squared Error of average weighted prices of the last trading day from election result
** Mean Relative Error of market closing prices from election result
Mean Relative Error of average weighted prices of the last trading day from election result

This shows (i) how critical it is which data we take for a comparison and (ii) that the forecasting performance of the two markets was overall approximately the same. WP closing prices are better, as a sharp "last minute" increase of SPD (up from 24 to 30.5, close to the election result of 31.9) led to a very good prognosis. The average weighted SPD-price on the last day (24.16) was much worse – and also worse than the value of W$ (28.06). This leads to higher forecasting errors for WP when we look at average prices and it reflects the higher volatility of WP. This finding can be confirmed by Figure 3: it shows the MAE of average prices for each trading day for both markets.

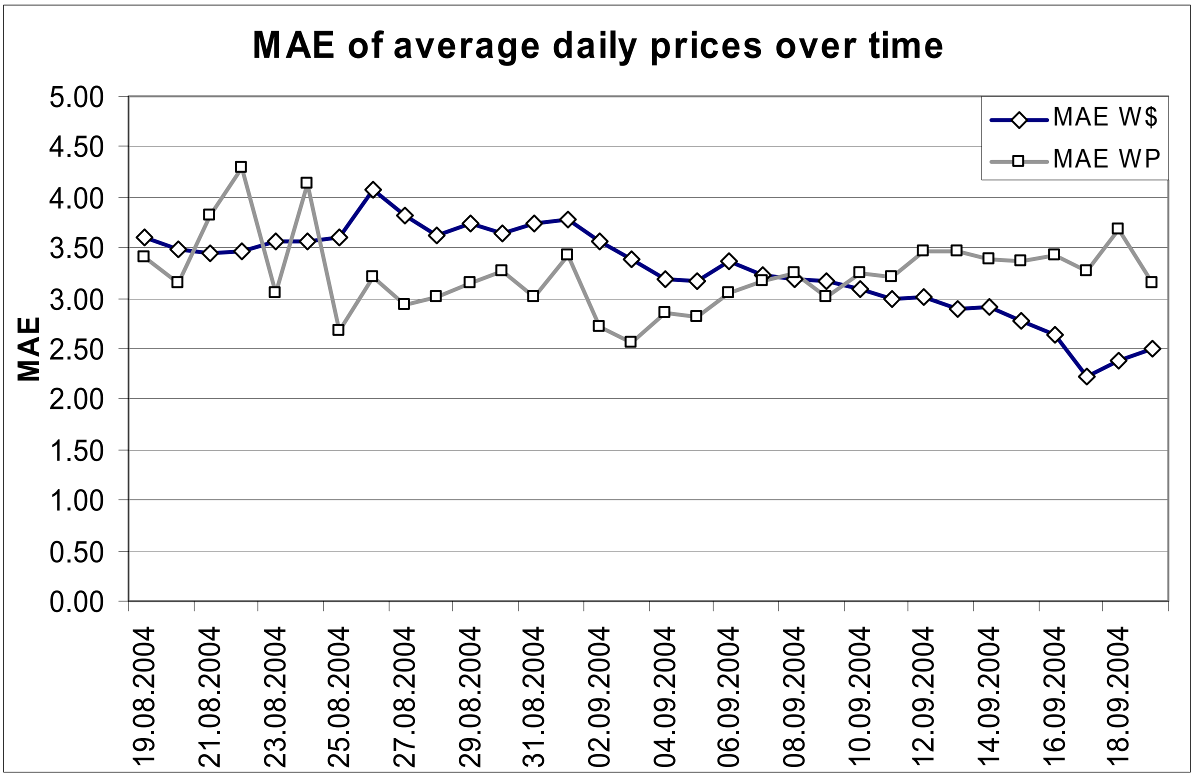

Figure 3: Development of daily MAE in both markets

We see that both markets start with an MAE of approximately 3.50. While the prices at WP are subsequently very volatile (reflected by the MAE changing from 4.3 to 3, on to 4 and back to 2.70 in just four days), the MAE of the real-money market W$ is much more stable. After a high point on the eight day, the MAE of W$ steadily decreases to a final forecasting error of 2.50. A similar "aggregation of information" can not be confirmed for WP: the MAE fluctuates between 2.50 and 3.50 for most of the time and finally settles at 3.15. We can conclude, that the higher volatility and more speculative trading in the no-money market does somewhat weaken its predictive accuracy. However, the closing prices were even more accurate at WP and this market was more precise in four of the six measures we applied. Summing up we can say that the forecasting ability of both markets is comparable and the lack of real money investment did not worsen the prediction.

VI Conclusion

In this paper we presented data from two political stock markets forecasting the outcome of a local election in Germany. The markets had almost identical design, the main difference being the incentive structure, as one market was run with real money while the other required no real money investment.

As expected we found the real-money market to display significantly more stable prices, a more even distribution of traders' wealth, and overall less speculative trading behaviour. However, it seems that the higher volatility and more active speculation in the no-money market do not weaken its forecasting ability, as we find the forecasting accuracy to be approximately the same for both markets.

As it is a major topic in experimental economics whether incentive structures in our experiments can capture real-world incentives, our finding is comforting. It seems that markets are quite robust to changes in the incentive structure, aggregating and disseminating information even when no real money is involved.

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