

# **COMPARING THE FORECASTING ACCURACY OF PREDICTION MARKETS AND POLLS FOR TAIWAN'S PRESIDENTIAL AND MAYORAL ELECTIONS**

<i>Chen-yuan Tung* , Graduate Institute of Development Studies, National Chengchi University Taiwan</i>	<i>Tzu-Chuan Chou Graduate Institute of National Development, National Chengchi University, Taiwan</i>	<i>Jih-wen Lin Institute of Political Science at Academia Sinica and National Chengchi University Taiwan</i>	<i>Hsin-yi Lin Department of Economics at the National Chengchi University Taiwan</i>
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## **ABSTRACT**

This paper devises a methodology to compare the accuracy of prediction markets and polls. The data of the Exchange of Future Events (xFuture) for Taiwan's 2006 mayoral elections and 2008 presidential election show that the prediction markets outperform the opinion polls in various indices of accuracy. In terms of the last forecast before the election date, the accuracy of the prediction markets is 3 to 10 percent higher than that of the opinion polls. When comparing the accuracy of historical forecasts, the prediction markets outperform the polls in 93 to 100 percent of the cases. Moreover, the average accuracy of the prediction markets is 9 to 10 percent higher than that of the polls, with a standard deviation more than 2 percent less than that of the polls. To examine the robustness of these comparisons, this paper conducts two tests including daily forecast and normalized accuracy, and finds that the prediction markets successfully pass the tests with a significantly better accuracy than the polls.

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\* Chen-yuan Tung, Professor, Graduate Institute of Development Studies, National Chengchi University, 64, Zhi-Nan Road, Sec. 2, Wenshan, Taipei, 11605, TAIWAN. E-mail: ctung@nccu.edu.tw

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## INTRODUCTION

Polling is one of the most commonly used methods to predict election results. In the recent two decades, however, the prediction markets (PM) have been gradually adopted as a research method to forecast election results in different countries. By definition, a prediction market is a market where the participants are allowed to trade “future event contracts” based on their judgment of contract price trends as well as event result predictions. Contract prices may be used as references to evaluate the chance of specific events occurring, as well as how they will occur. For each contract, the prediction markets will set the “prediction event”, “settlement basis” and “expiry date”. The settlement price on the expiry date will be determined by whether the event has occurred or not and how it occurs. The prediction markets operate like the futures market, and can be used as a mechanism to integrate information from different sources to predict the outcomes of future events.<sup>1</sup>

Using the trade data of the “Intrade” prediction markets<sup>2</sup>, Ken Allen et al. (2004) conducted an analysis of the 2004 U.S. presidential and congressional elections. Their findings were that prediction markets very accurately predicted the results of the two elections, including the winner of the total electoral votes and popular votes. Prediction markets also very accurately predicted the results of presidential election in fifty states, as well as the results in 33 states (out of 34) that held senate elections. Focusing on the 2004 U.S. presidential election, Walker (2006) compared and analyzed the forecast results of different econometric models, polls and the prices of the Iowa Electronic Market (IEM).<sup>3</sup> He discovered that the closing price of the IEM on the last day and the Generalized Fair Model developed by economists were the most accurate methods to predict the vote shares received by George Bush.

Berg, Nelson and Rietz (2008) analyzed the IEM’s trade data over a long-term basis and compared the data with 964 poll results for presidential elections during the period from 1988 to 2004. They found that more than 74 percent of the time the prediction markets achieved a closer result to the final vote shares of the two major parties when compared with the polls. Erikson

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<sup>1</sup> For the operational mechanism in prediction markets, please refer to Tung et al. and to the website of the Exchange of Future Events: <http://xfuture.org>.

<sup>2</sup> The website is: <http://www.intrade.com>.

<sup>3</sup> The website is: <http://www.biz.uiowa.edu/iem>.

and Wlezien (2008) on the other hand used the poll information from 1952 to 1984 to modify the poll results of 1988 to 2004 by a regression analysis. Their findings were that the modified poll results had a much higher accuracy than the prediction markets. In terms of vote shares, the modified polls were 55 percent of the time more accurate than the prediction markets. As for the probability of winning, the modified polls were closer to the results than the prediction markets 87 percent of the time.

Focusing on the 1993 Canadian Federal Election, Forsythe et al. (1995) discovered that, when compared with the major polls for the three days prior to the election, the prediction markets achieved a closer forecast to the final results. In terms of seat shares, the prediction markets were nevertheless not that accurate. As a whole, the prediction markets were quite instrumental in the integration of information. Focusing on the three elections held in the Netherlands in 1994, including the elections for counselors, the Netherlands Parliament and the European Parliament, Jacobsen et al. (2000) discovered that the PAM94 Prediction Markets in the Netherlands had not achieved any better results than the polls. Further, they also found that poll results and political tendencies had not dominated the formation of market prices.

Wolfers and Leigh (2002) compared three forecast methods of the 2001 federal election in Australia: econometric models based on macro economic variables, polls and prediction markets. Their findings were that polls turned out to be quite accurate only during the few days prior to the election. Econometric models, on the other hand, achieved accurate predictions for the mid- and short-terms. Prediction markets not only accurately forecasted the overall election results, but also the results of each individual candidate. Leigh and Wolfers (2006) also compared the three forecast methods of the 2004 federal election in Australia and discovered that prediction markets achieved better accuracy, as well as lower variance, than econometric models and polls.

Applying prediction markets to the elections in Taiwan, Tung et al. (2009) analyzed the trade data of the "Exchange of Future Events" (xFuture, <http://xfuture.org>), the largest Chinese-language prediction market in the world, from the mayoral elections in Taipei and Kaohsiung in December 2006, the legislative election in January 2008 and the presidential election in March 2008. They found that prediction markets precisely forecasted the results of the three elections well before the day of election. When compared with the latest unweighted poll results conducted by various polling institutions before the election, prediction markets had a better accuracy in terms of performance on the last day prior to the election. This research, however, only provided the comparison of the last polls released by different polling institutions against the last-day results of the prediction markets. Their research did not provide a comprehensive analysis of the long-term accuracy of these two forecasting methods.

Furthermore, the method of prediction markets deserves scrutinizing its efficacy of predicting election results in Taiwan for three more reasons. First, compared with its Western counterparts, Taiwan is a young East Asian democracy where voting behavior is presumably more volatile. Although partisan identification has been a major factor explaining vote choices made by the Taiwanese voters, personal vote is prevalent and difficult to explain. Opinion survey showing the importance of partisan identification may still be inadequate to predict the election results. Second, polling in Taiwan is a young industry that may leave insufficient time for the pollsters to redress the commonly committed errors (such as the significant non-response rate). A browse of the studies published by Taiwan's leading election experts reveals that very few works based on opinion surveys were published before the 1990s, which is several decades later than the United States. Third, despite these limits, polling is still the most commonly used method to predict election results in Taiwan. It is thus the purpose of this paper to provide a systematic comparison between the accuracy of the polls and prediction markets, focusing on the 2006 mayoral and 2008 presidential elections in Taiwan.

To make the comparison between prediction markets and polls credible, the next section will discuss the methodological issues and propose several methods of comparison. Section three will apply these methods to Taiwan's 2006 mayoral elections and 2008 presidential election, followed by two robust tests of the comparison. The last section concludes by summarizing the results of the comparison and the contributions of this paper.

## **METHODOLOGY**

When analyzing the long-term accuracy of the polls and prediction markets for the US presidential election results during the period from 1988 to 2004, Berg, Nelson and Rietz (2008) adopted the approach of normalized spread on contract prices (or vote shares predicted) of the candidates of the two major political parties. This method can be broken down as follows:

1. Distribute the contract price (or vote shares predicted) of the non-democratic or non-republican candidates, as well as interviewees who have not disclosed their standings, to the candidates of the two major political parties based on the ratio of their contract prices (or vote shares predicted).
2. Divide the sum of the contract prices (or vote shares predicted) of the candidates of the two parties by the difference of their contract prices (or vote shares predicted) to achieve the normalized spread on contract prices (or vote shares predicted) of the

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candidates of the two major political parties. Using the two candidates (William J. Clinton and Robert J. Dole) of the 1996 US presidential election as an example, the formulae to calculate the normalized spread on contract prices of the candidates of the two major political parties ( $S_{Clinton-Dole,t}^{VS}$ ) and the normalized spread on vote shares predicted of the candidates of the two major political parties ( $S_{Clinton-Dole,t}^{Poll}$ ) are as follows:

$$S_{Clinton-Dole,t}^{VS} = \frac{P_{Clinton,t}^{VS} - P_{Dole,t}^{VS}}{P_{Clinton,t}^{VS} + P_{Dole,t}^{VS}}$$

$$S_{Clinton-Dole,t}^{Poll} = \frac{r_{Clinton,t}^{Poll} - r_{Dole,t}^{Poll}}{r_{Clinton,t}^{Poll} + r_{Dole,t}^{Poll}}$$

of which:

$S_{Clinton-Dole,t}^{VS}$ : normalized spread on contract prices of the candidates of the two major political parties in the prediction markets.

$P_{Clinton,t}^{VS}$ : the closing price at day  $t$  for Clinton's contracts in the prediction markets.

$P_{Dole,t}^{VS}$ : the closing price at day  $t$  for Dole's contracts in the prediction markets.

$S_{Clinton-Dole,t}^{Poll}$ : normalized spread on vote shares predicted of the candidates of the two major political parties by poll.

$r_{Clinton,t}^{Poll}$ : the percentage of vote shares predicted for Clinton at day  $t$  by poll.

$r_{Dole,t}^{Poll}$ : the percentage of vote shares predicted for Dole at day  $t$  by poll.

For the following five reasons, however, this paper will not use the above approach to compare the accuracy of the polls and the prediction markets:

1. The two leading candidates in Taiwan's elections do not always represent the two major political parties, the Kuomintang (KMT) and the Democratic Progressive Party (DPP). In certain areas, the winner of a mayor/magistrate election either represents a third political party or does not represent any party. Sometimes candidates from the same political party may compete with one another in an election or none of the KMT or DPP candidates are considered major candidates.

2. By adopting the normalized spread approach, Berg, Nelson and Rietz have distributed the support rate for “other candidates” and for those who have not disclosed their standings to the candidates of the two major political parties on a proportional basis. This may not be a plausible approach, because some respondents not disclosing their standings for the leading candidates may have a particular partisan tendency that they do not want to reveal. For the polls in Taiwan, a large percentage of respondents do not disclose their standings in elections. The percentage is usually more than 20 percent. This is, by nature, a defect of the polling system. It is therefore improper to justify the defect and distribute the support rate of these interviewees to candidates of the two major political parties on a proportionate basis.
3. The normalized spread approach aimed to normalize the prices in prediction markets and avoid the total price of linked contracts from exceeding or falling below 1. This is, however, an unfair approach for assessing poll accuracy. For the polls, the sum of support rates for individual candidates and undecided or undisclosed respondents should be 100 percent, which makes normalization unnecessary. In Taiwan’s 2008 presidential election, for example, the vote share of Ying-jeou Ma and Chang-ting Hsieh was 58.5 percent and 41.5 percent respectively. The prediction markets could have two different forecasts in the contract price, the first being 60 for Ying-jeou Ma and 40 for Chang-ting Hsieh, and the second being 96 for Ying-jeou Ma and 64 for Chang-ting Hsieh. While the former is obviously more accurate than the latter, the “normalized spread” is the same for both, i.e., 20 percent.
4. The normalized spread approach can only be adopted for accuracy analysis on two valid candidates and is hardly feasible for more than two candidates.
5. Further, the normalized spread approach only highlights the absolute difference between the contract prices (or vote shares predicted) of the two candidates, but does not predict who the winner would be. For example, whilst one poll would forecast Ma to win 60 percent of the votes and Hsieh 40 percent, the other would contrarily forecast Ma to win 40 percent and Hsieh 60 percent. The normalized spread for both the polls is the same, in spite of the fact that the accuracy of the former is much higher than the accuracy of the latter.

To solve the above problems, this paper assesses election prediction accuracy by deducting the mean absolute error (MAE) of the predicted vote share for each candidate in a single electoral district from 1. For the polls,  $MAE_{Poll}$  refers to the mean absolute error of the predicted vote share for each candidate in a specific electoral district, as against the actual vote share. For prediction markets,  $MAE_{PM}$  is the average value of the “absolute error” of election contracts in a specific electoral district (i.e., the difference between the weighted average contract price and the settlement price, divided by 100).<sup>4</sup> Theoretically, this methodology does not guarantee that the “accuracy” would be between 0 and 1, since both  $MAE_{PM}$  and  $MAE_{Poll}$  could be more than 1. However this would only occur when the forecast results turn out to be quite incorrect, the probability of which is very small. The formulae for calculating accuracy and MAE are as follows:

$$Accuracy_{Poll} = 1 - MAE_{Poll}$$

$$MAE_{Poll} = \frac{1}{n} \left[ \sum_{i=1}^n |VS^{Poll}_i - VS^{Actual}_i| \right]$$

$VS^{Poll}_i$  : the vote share (%) of the  $i_{th}$  candidate by poll forecast.

$VS^{Actual}_i$  : the actual vote share (%) of the  $i_{th}$  candidate.

$n$  : the number of candidate contracts in a specific electoral district.

$$Accuracy_{PM} = 1 - MAE_{PM}$$

$$MAE_{PM} = \frac{1}{n} \left[ \sum_{i=1}^n \left| \frac{P_i - P^S_i}{100} \right| \right]$$

$P_i$  : the weighted average price of the  $i_{th}$  contract in the prediction markets.

$P^S_i$  : the settlement price of the  $i_{th}$  contract in the prediction markets.

$n$  : the number of contracts in a specific electoral district.

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<sup>4</sup> For the vote share contracts in prediction markets, the price for each unit represents a 1% vote share in the market. To compute the vote share of the candidate, therefore, we need to divide the price by 100. The settlement price for the vote share contracts is achieved by multiplying the actual vote share of the candidate with 100.

In this paper, the poll data is collected from the polls released by various polling institutions in Taiwan. The trade information for the prediction markets is collected from xFuture. Based on the above definitions, this research provides an analysis of the accuracy of vote shares predicted by the polls and by the prediction markets respectively from the following three aspects:

1. Comparing the accuracy of the latest polls conducted by different polling institutions before the election date against that of the prediction markets on the day before the election. In the event that there are no transactions in the prediction markets on the day prior to the election, the weighted average trade price of the latest date is used for comparison.
2. Comparing the accuracy of historical poll results against the accuracy of the prediction markets on the day before the publication of the specific polls. This is done to avoid an influence of poll results on the prediction markets prices and achieve a fairer comparison between polls and prediction markets.
3. Comparing the mean value and variance of the indicators of accuracy of polls and prediction markets. The data to be analyzed include all samples, samples from more than 30 days before the election, samples from 21-30 days before the election, samples from 11-20 days before the election, and samples from 1-10 days before the election. Because polling institutions do not provide daily information on the support rate of each candidate, this research only focuses on the accuracy of various historical poll results. To calculate the accuracy of the prediction markets, this paper adopts the daily weighted average price in the prediction markets. In the event that there is no transaction on that day, the weighted average trade price of the previous day is used for the comparison until new trade data is available.

To identify the degree of election competition, we calculate the number of the effective candidates (NEC), the formula for which is:

$$NEC = \frac{1}{\sum_{i=1}^n p_i^2}$$

where  $P_i$  is the vote share of the  $i_{th}$  candidate and  $N$  the total number of candidates.

For a given  $N$ , the larger the NEC is, the more competitive the election is, and vice versa. Cox (1997) has developed the Duvergerian Relationship to summarize the correlation between the electoral system and the number of competitors involved in the election, i.e., the NEC of each electoral district



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will be the number of electable seats in the electoral district plus one. This is the so-called "M+1 Rule", where M stands for the electable seats in a specific electoral district. For mayoral/magistrate, legislative, and presidential elections that elect only one winner (in a district), the NEC should be close to two.

Our analysis will focus on the candidates whose vote share is ranked above the value of the NEC (henceforth called the NEC candidates). The reason is that the contracts of the "bubble" candidates who have no chance of winning will probably have no trade at all, which makes it difficult to compare the accuracy between polls and prediction markets. In days when even the contracts of the NEC candidates in the prediction market have no trade, this paper will use the weighted average price of the previous day as the price for that day, and this price will be used until new trade prices are available. This paper will start to compute the first value of accuracy in the prediction markets only when the traders have conducted transactions on all NEC candidates for the same day.

To make sure that the comparison between polls and prediction markets is not biased as explained previously, this paper will conduct two robustness tests:

1. Comparing the accuracy of the latest poll against the accuracy of the prediction markets on a daily basis. When more than one poll result is announced on a single day, the average value is adopted. In days when no poll result is published, the latest poll results are adopted. If there is no trade in the prediction markets on the day the poll results are published, the weighted average trade price of the most recent date is adopted.
2. Comparing the normalized accuracy of the polls against that of the prediction markets.

For the prediction markets, "normalization" refers to the process of dividing the price of individual contracts by the sum of all contract prices in a specific electoral district. After the normalization process, the sum of all contract prices in any specific electoral district shall equal to 1. For the polls, "normalization" refers to the process of distributing the standing of the undisclosed or undecided respondents to the candidates in proportion to their support rate. The sum of poll support rates for all candidates in the specific electoral district, after the normalization process, shall equal to 1. In other words, the range of normalized accuracy for both polls and the prediction markets shall be between 0 and 1. The calculation for "normalized accuracy" is as follows:

$$\text{Accuracy}_{\text{PM}}^{\text{Normalization}} = 1 - \text{MAE}_{\text{PM}}^{\text{Normalization}}$$

$$\text{MAE}_{\text{PM}}^{\text{Normalization}} = \frac{1}{n} \left[ \sum_{i=1}^n \left| \tilde{P}_i - \frac{P_i^S}{100} \right| \right]$$

$$\tilde{P}_i = \frac{P_i}{\sum_{i=1}^n P_i}$$

$\tilde{P}_i$  : the normalized weighted average price for the  $i_{th}$  contract in the prediction markets.

$P_i$  : the weighted average price for the  $i_{th}$  contract in the prediction markets.

$P_i^S$  : the settlement price for the  $i_{th}$  contract in the prediction markets.

$n$  : the total number of contracts in a specific electoral district.

$$\text{Accuracy}_{\text{Poll}}^{\text{Normalization}} = 1 - \text{MAE}_{\text{Poll}}^{\text{Normalization}}$$

$$\text{MAE}_{\text{Poll}}^{\text{Normalization}} = \frac{1}{n} \left[ \sum_{i=1}^n \left| \tilde{VS}_i^{\text{Poll}} - VS_i^{\text{Actual}} \right| \right]$$

$$\tilde{VS}_i^{\text{Poll}} = VS_i^{\text{Poll}} + VS^{\text{NA}} \left( \frac{VS_i^{\text{Poll}}}{\sum_{i=1}^n VS_i^{\text{Poll}}} \right)$$

$\tilde{VS}_i^{\text{Poll}}$  : the normalized poll vote share for the  $i_{th}$  candidate.

$VS_i^{\text{Poll}}$  : the poll vote share predicted for the  $i_{th}$  candidate.

$VS^{\text{NA}}$  : the ratio of the undisclosed/undecided poll share in a specific electoral district.

$VS_i^{\text{Actual}}$  : the actual vote share of the  $i_{th}$  candidate.

$n$  : the total number of contracts in a specific electoral district.

## THE 2006 MAYORAL ELECTIONS IN TAIPEI AND KAOHSIUNG

### THE ELECTION PROFILE

The deadline for candidate registration for the 2006 mayoral elections in the cities of Taipei and Kaohsiung, Republic of China (Taiwan), was October 19, 2006. The total number of candidates was six in Taipei and five in Kaohsiung. The results of the election were announced on December 9, 2006. Long-bin Hao (KMT) was elected the mayor of Taipei with a vote share of 53.81 percent and Chang-ting Hsieh (DPP) lost the election with a vote share of 40.89 percent. In Kaohsiung, Chu Chen (DPP) won the election with a vote share of 49.41 percent, while Chun-ying Huang (KMT) lost the election with 49.27 percent, a minimal difference of less than 0.2 percent (See Table 1 and Table 2).

**TABLE 1. Election results of the 2006 Taipei mayoral election**

Political Party	Candidate	Vote Share
Non-Party	Ao Li	0.61%
Taiwan Solidarity Union	Yu-kou Chou	0.26%
Democratic Progressive Party	Chang-ting Hsieh	40.89%
Non-Party	James Chu-yu Sung	4.14%
Kuomintang	Long-bin Hao	53.81%
Independent	Szu-hai Ko	0.29%

Source: The Central Election Commission, Republic of China (Taiwan).

**TABLE 2. Election results of the 2006 Kaohsiung mayoral election**

Political Party	Candidate	Vote Share
Kuomintang	Chun-ying Huang	49.27%
Taiwan Defense Alliance	Chi-sheng Lin	0.23%
Taiwan Solidarity Union	Chi-ming Lin	0.86%
Independent	Jin-yuan Lin	0.23%
Democratic Progressive Party	Chu Chen	49.41%

Source: The Central Election Commission, Republic of China (Taiwan).

## ACCURACY ANALYSIS OF THE POLLS AND THE PREDICTION MARKETS

### *Comparing the Accuracy of the Latest Poll before the Election against the Accuracy of the Prediction Markets*

The following tables show the accuracy of the latest forecasts before the 2006 mayoral elections in Taipei and Kaohsiung conducted by the xFuture and different polling institutions. For the 2006 mayoral election in Taipei, the accuracy of the last prediction markets' results before the election is 99.14 percent, which is more than 10 percent higher than the accuracy of the poll results announced on the last day by the polling institutions. For the mayoral election in Kaohsiung, the accuracy of the last prediction markets' results before the election is 95.95 percent, which is also 3 percent higher than the accuracy of the poll results announced on the last day by the polling institutions. Among the polling institutions, TVBS has the highest accuracy, with accuracy rates of 89.15 percent and 92.93 percent respectively for the last polls of the mayoral elections in Taipei and Kaohsiung.

**TABLE 3: The accuracy of the latest poll before the election against the accuracy of the prediction markets in the 2006 Taipei mayoral election**

Prediction agency	ERA	United Daily	TVBS	China Times	Prediction Markets
Time	2006/11/27	2006/12/2	2006/12/5	2006/12/5	2006/12/9
Accuracy	82.65%	83.15%	89.15%	87.65%	99.14%

**TABLE 4: The accuracy of the latest poll before the election against the accuracy of the prediction markets in the 2006 Kaohsiung mayoral election**

Prediction agency	ET Today	ERA	United Daily	China Times	Liberty Times	TVBS	Prediction Markets
Time	2006/11/24	2006/11/26	2006/12/2	2006/12/4	2006/12/5	2006/12/6	2006/12/9
Accuracy	70.65%	84.16%	83.66%	86.66%	84.90%	92.93%	95.95%

### *Comparing the Accuracy of Historical Polls against the Accuracy of the Prediction Markets*

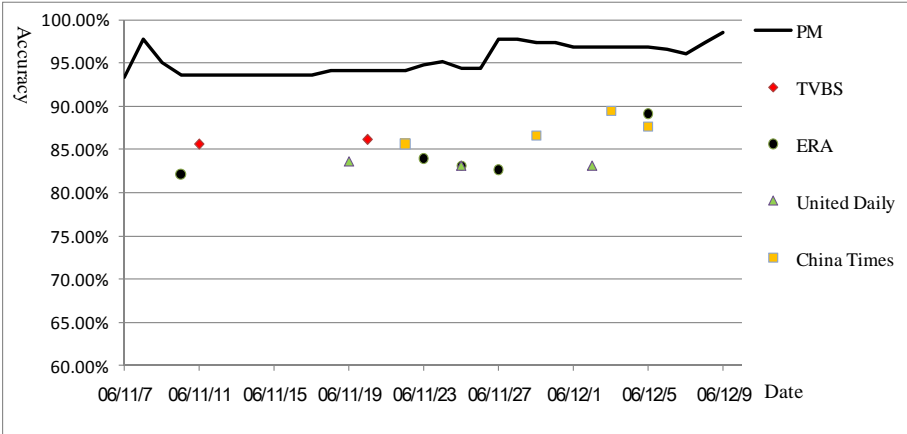
The figures below illustrate the distribution of the accuracy levels of historical polls conducted by different polling institutions for the 2006

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mayoral elections in Taipei and Kaohsiung. Figure 1 suggests that for the mayoral election in Taipei the accuracy of prediction markets is always higher than the accuracy of the polls. Figure 2 demonstrates that for the mayoral election in Kaohsiung prediction markets have outperformed all polls, with the only exception being November 5, when the accuracy of prediction markets is lower than the TVBS poll. For the election in Taipei, the prediction markets are all closer to the eventual outcome;<sup>5</sup> in Kaohsiung, the prediction markets are closer to the final outcome 93 percent of the time.<sup>6</sup> We conclude that, for this comparison, the prediction markets outperform the polls in terms of predicting election results.

According to Table 5, the performance of the prediction markets for the mayoral election in Taipei is, as a whole, better than that of the polls. The average accuracy of all forecast data in the prediction markets is 95.5 percent, higher than the 84.15 percent of the polls. The standard deviation of all forecast data in the prediction markets is 1.78 percent, lower than the 2.85 percent of the polls. In the ten days before the election date, the average accuracy of the prediction markets is higher than that of the polls, while the standard deviation in the prediction markets is about 2 percent lower than that of the polls.

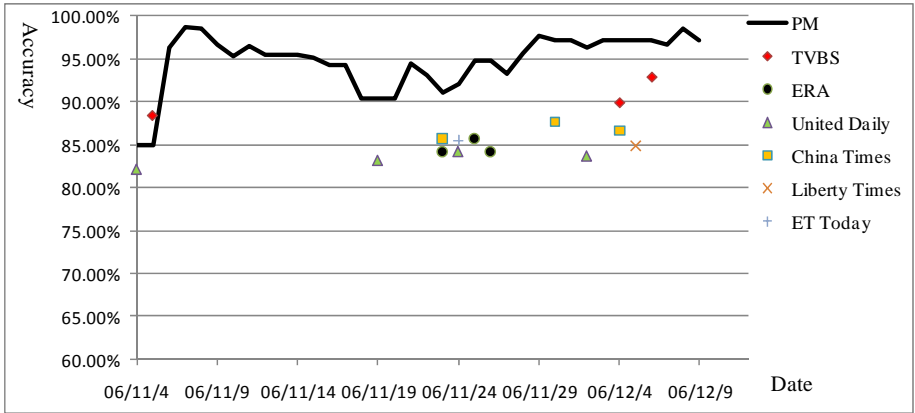
**FIGURE 1: The accuracy of historical polls against the accuracy of the prediction markets in the 2006 Taipei mayoral election**



<sup>5</sup> According to binominal tests of the relative accuracy of the prediction markets and the polls, the *p*-value (1 sided) is 0.000.

<sup>6</sup> According to binominal tests of the relative accuracy of the prediction markets and the polls, the *p*-value (1 sided) is 0.001.

**FIGURE 2: The accuracy of historical polls against the accuracy of the prediction markets in the 2006 Kaohsiung mayoral election**



*The Average and Standard Deviation of the Accuracy of the Prediction Markets and the Polls*

For the mayoral election in Kaohsiung, as displayed in Table 6, the average accuracy and standard deviation of the prediction markets are poorer than those of the polls for the time period of more than 30 days prior to the election date. In other time periods, however, the prediction markets have outperformed the polls.

**TABLE 5: The average and standard deviation of the accuracy of the prediction markets and the polls in the 2006 Taipei mayoral election**

Days prior to the election	Prediction markets		Opinion polls	
	Average	Standard deviation	Average	Standard deviation
All (from the beginning of the market)	95.50%	1.7837%	84.15%	2.8514%
More than 30 days	94.70%	1.8396%	83.31%	2.9810%
21-30 days	93.78%	0.2623%	83.90%	2.4784%
11-20 days	95.74%	1.6258%	84.29%	1.2972%
1-10 days	97.20%	0.9458%	86.45%	2.9380%

Note: There were 31 poll predictions on the 2006 Taipei mayoral election from July 6 until December 9, 2006.

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During the period of ten days before the election date, the average accuracy of the prediction markets is 9.42 percent higher than the polls and the standard deviation in the prediction markets is 2.7 percent lower than that of the polls. In sum, the prediction markets have a higher accuracy and lower standard deviation when compared with the polls.

**TABLE 6: The average and standard deviation of the accuracy of the prediction markets and the polls in the 2006 Kaohsiung mayoral election**

Days prior to the election	Prediction markets		Opinion polls	
	Average	Standard deviation	Average	Standard deviation
All (from the beginning of the market)	91.69%	8.4170%	85.21%	3.2569%
More than 30 days	83.85%	11.8124%	84.25%	3.6539%
21-30 days	93.81%	2.4240%	NA	NA
11-20 days	94.40%	2.1094%	84.65%	0.9724%
1-10 days	97.04%	0.6791%	87.62%	3.3930%

Note: There were 24 poll predictions on the 2006 Kaohsiung mayoral election from July 20 until December 9, 2006.

## TWO ROBUST TESTS

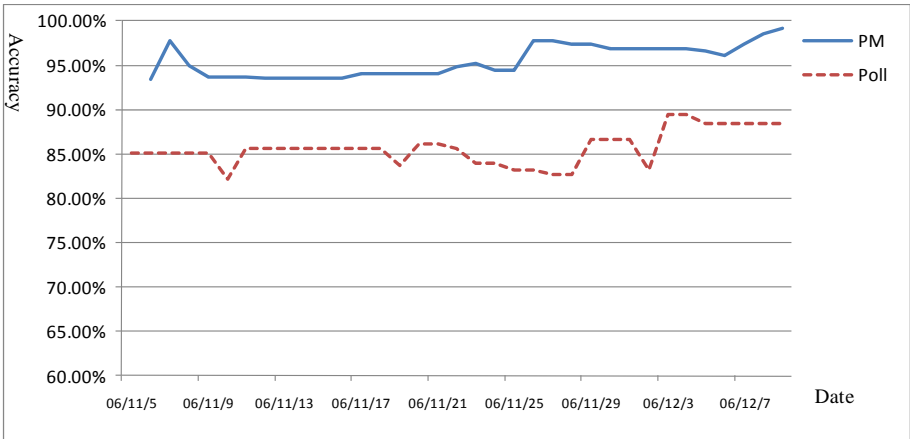
### *Comparing the Accuracy of the Latest Poll against the Accuracy of Prediction Markets on a Daily Basis.*

For the mayoral election in Taipei, the accuracy of the prediction markets is always higher than the polls. For the mayoral election in Kaohsiung, the accuracy of the prediction markets at 72.43 percent is obviously lower than that of the polls at 84.10 percent before November 2, 2006. After November 3, 2006, the accuracy of the prediction markets becomes higher than the polls across the entire time period. For the 2006 mayoral election in Taipei, the prediction markets are all closer to the eventual outcome.<sup>7</sup> For the mayoral election in Kaohsiung, the prediction markets are closer to the eventual

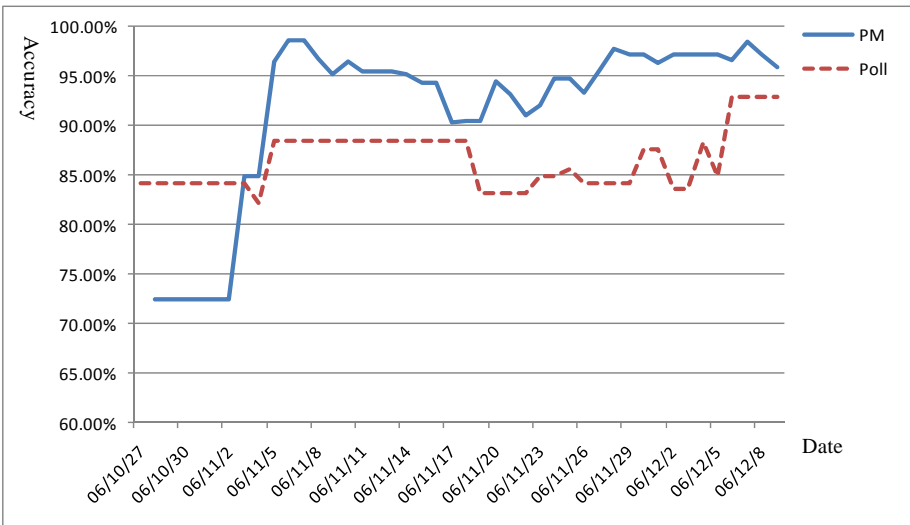
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<sup>7</sup> According to binominal tests of the relative accuracy of the prediction markets and the daily poll predictions in the 2006 Taipei mayoral elections, the *p*-value (1 sided) is 0.000.

**FIGURE 3: The accuracy of the latest poll against the accuracy of prediction markets on a daily basis in the 2006 Taipei mayoral election**



**FIGURE 4: The accuracy of the latest poll against the accuracy of prediction markets on a daily basis in the 2006 Kaohsiung mayoral election**



outcome in 37 out of a total of 43 observations, with a percentage of 86.<sup>8</sup> For the time period beyond 30 days before the election date, the prediction

<sup>8</sup> According to binominal tests of the relative accuracy of the prediction markets and the daily poll predictions in the 2006 Kaohsiung mayoral elections, the *p*-value (1 sided) is 0.000.



markets are closer to the eventual outcome 54 percent of the time.<sup>9</sup> For the time period of 1-30 days before the election, the prediction markets are all strictly closer to the eventual outcome than the polls.<sup>10</sup> (see Figure 3 and Figure 4)

*Comparing the Normalized Accuracy of the Polls against that of the Prediction Markets on a Daily Basis*

Figures 5 and 6 depict the comparisons of the normalized accuracy of the prediction markets against that of various polls for the 2006 mayoral elections in Taipei and Kaohsiung. For the mayoral election in Taipei, the accuracy of the prediction markets is about 5 to 10 percent better than that of the polls. Furthermore, the normalized accuracy of the prediction markets is higher than the polls in 100 percent of the cases.<sup>11</sup> For the mayoral election in Kaohsiung, the normalized accuracy of the prediction markets is significantly lower than that of the polls before November 2. After November 5, the normalized accuracy of the prediction markets becomes higher than that of the polls throughout the period. The normalized accuracy of the prediction markets is higher than that of the polls in 79 percent of the 43 observations.<sup>12</sup> Further analysis shows that during the period of more than 30 days before the election day, the normalized accuracy of the prediction markets is higher than the polls 38 percent of the time.<sup>13</sup> During the period within 30 days before the election date, the ratio has risen to 97 percent.<sup>14</sup>

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<sup>9</sup> According to binominal tests of the relative accuracy of the prediction markets and the daily poll predictions in the 2006 Kaohsiung mayoral elections, the  $p$ -value (1 sided) is 0.500.

<sup>10</sup> According to binominal tests of the relative accuracy of the prediction markets and the daily poll predictions in the 2006 Kaohsiung mayoral elections, the  $p$ -value (1 sided) is 0.000.

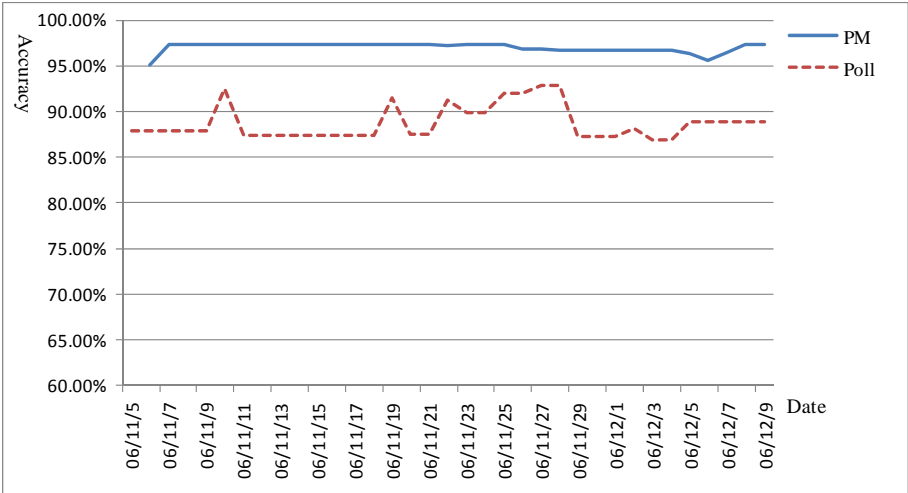
<sup>11</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the poll results in the 2006 Taipei mayoral elections, the  $p$ -value (1 sided) is 0.000.

<sup>12</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the poll results in the 2006 Kaohsiung mayoral elections, the  $p$ -value (1 sided) is 0.000.

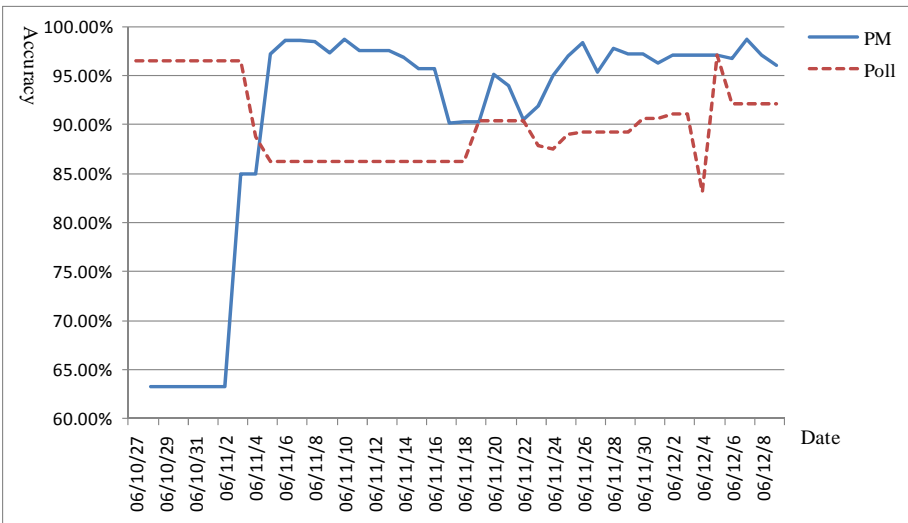
<sup>13</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the poll results in the 2006 Kaohsiung mayoral elections, the  $p$ -value (1 sided) is 0.867.

<sup>14</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the poll results in the 2006 Kaohsiung mayoral elections, the  $p$ -value (1 sided) is 0.000.

**FIGURE 5: The normalized accuracy of the polls against that of the prediction markets on a daily basis in the 2006 Taipei mayoral election**



**FIGURE 6: The normalized accuracy of the polls against that of the prediction markets on a daily basis in the 2006 Kaohsiung mayoral election**



**THE 2008 PRESIDENTIAL ELECTION IN TAIWAN**

**THE ELECTION PROFILE**

The 12th presidential election of the Republic of China (Taiwan) was held on March 22, 2008. Only two teams of candidates joined the race, and the KMT and the DPP were respectively represented by candidates Ying-jeou Ma and Chang-ting Hsieh. Eventually Ma was elected with a vote share of 58.5 percent, and Hsieh lost the election with a vote share of 41.5 percent (See Table 7).

**TABLE 7: The result of the 2008 presidential election in Taiwan**

Party	Candidate	Vote share
Democratic Progressive Party	Chang-ting Hsieh	41.5%
Kuomintang	Ying-jeou Ma	58.5%

Source: The Central Election Commission, Republic of China (Taiwan).

**ACCURACY ANALYSIS ON THE POLLS AND THE PREDICTION MARKETS**

*Comparing the Accuracy of the Last Poll before the Election against the Accuracy of the Prediction Markets*

Among the institutions that released their polling results for this presidential election, TVBS was the best performer with the highest accuracy of 90 percent.

**TABLE 8: The accuracy of the latest poll before the election against the accuracy of the prediction markets in the 2008 presidential election**

Prediction agency	Apple Daily	United Daily	China Times	TVBS	Prediction markets
Time	2008/3/7	2008/3/10	2008/3/10	2008/3/21	2008/3/21
Accuracy	80.55%	87.00%	85.50%	90.00%	97.55%

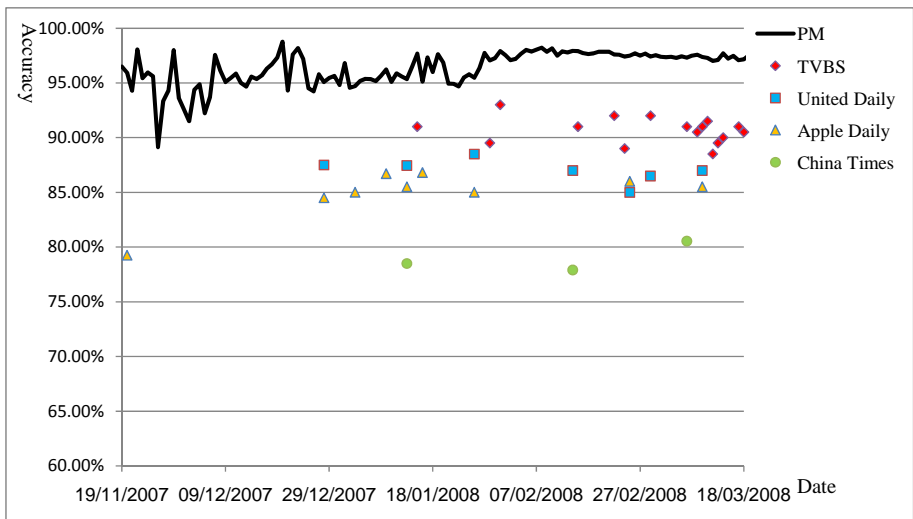
It should be noted that, despite the regulations that polling institutions are not allowed to reveal any poll results in the ten days before the presidential election, TVBS still conducted eight polls before the election, which were

announced on its website after the election. For this research, the poll data for the last ten days prior to the election was all collected from TVBS. As shown in Table 8, the prediction markets achieved 97.55 percent accuracy for the last pre-election forecast, which is over 7 percent higher than the accuracy of the polls.

### *Comparing the Accuracy of Historical Polls against the Accuracy of the Prediction Markets*

Figure 7 depicts the distribution of the accuracy level of historical polls conducted by different polling institutions for Taiwan's 2008 presidential election. As shown in the figures, the accuracy of prediction markets is always higher than that of the polls, with an average accuracy of approximately 96 percent. In contrast, the accuracy of the polls is roughly ranged between 85 percent and 92 percent. Of the 28 observations, the prediction markets are closer to the actual outcome 100 percent of the time in all time periods.<sup>15</sup> In brief, polls never outperformed the prediction markets.

**FIGURE 7: The accuracy of historical polls against the accuracy of the prediction markets in the 2008 presidential election**



<sup>15</sup> According to binominal tests of the relative accuracy of the prediction markets and historical polls in the 2008 presidential election, the  $p$ -value (1 sided) is 0.000.

COMPARING THE FORECASTING ACCURACY OF PREDICTION MARKETS AND  
POLLS FOR TAIWAN'S ELECTIONS

*The Average and Standard Deviation for the Accuracy of the Prediction Markets and the Polls*

As shown in Table 9, the average accuracy of the prediction markets as a whole is 96.32 percent, which is much higher than that of all polls (87.31 percent). The standard deviation for the accuracy of the prediction markets is 1.70 percent, which is significantly lower than that of the polls (4.18 percent). Within the 10 days prior to the election, the average accuracy of the prediction markets is higher than that of the polls by 7.13 percent, with standard deviation lower than that of the polls by 0.79 percent.

**TABLE 9: The average and standard deviation on accuracy of the prediction markets and the polls in the 2008 presidential election**

Days prior to the election	Prediction markets		Opinion polls	
	Average	Standard deviation	Average	Standard deviation
All (from the beginning of the market)	96.32%	1.7021%	87.31%	4.1759%
More than 30 days	95.97%	1.8095%	86.00%	4.5151%
21-30 days	97.53%	0.1140%	88.42%	3.0727%
11-20 days	97.35%	0.1502%	88.15%	4.0640%
1-10 days	97.44%	0.2804%	90.31%	1.0670%

Note: There were 127 prediction market predictions on the 2008 Presidential election from November 16, 2007 to March 21, 2008, while there were 49 poll predictions from August 13, 2007 until March 21, 2008.

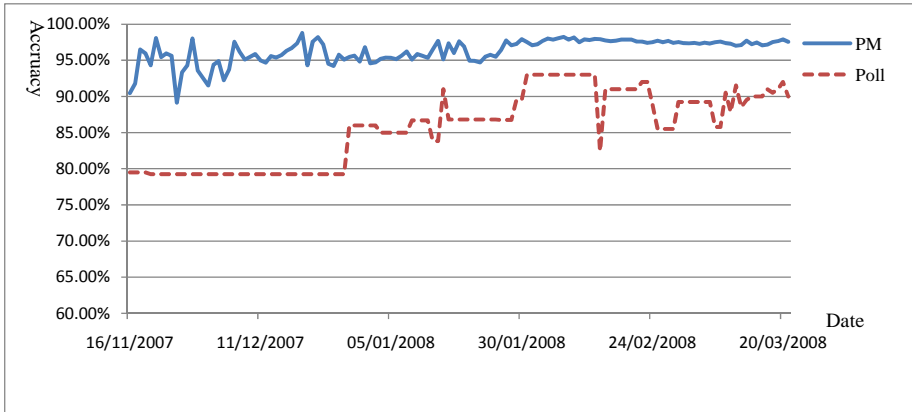
**TWO ROBUST TESTS**

*Comparing the Accuracy of the Latest Polls against the Accuracy of the Prediction Markets on a Daily Basis*

Figure 8 illustrates the accuracy of the latest polls and that of the prediction markets for the 2008 presidential election on a daily basis. This figure shows that the prediction markets always outperform the polls. Before December 28, 2007, the accuracy of the prediction markets is higher than the polls by about 15 percent. The difference gradually reduces to around 10

percent after December 28. With a total number of observations at 127, the prediction markets outperform the polls in all observations.<sup>16</sup>

**FIGURE 8: The accuracy of the latest polls against the accuracy of prediction markets on a daily basis in the 2008 presidential election**



*Comparing the Normalized Accuracy of Daily Polls against that of the Prediction Markets*

Figure 9 illustrates the comparisons between the normalized accuracy of the prediction markets and the accuracy of various polling results for the 2008 presidential election. Before December 1, 2007, the prediction markets and the polls were fifty-fifty in terms of their accuracy. After December 1, 2007 however, the normalized accuracy of the prediction markets becomes higher than that of the polls all the time. It is noteworthy that the difference between the prediction markets and the polls begins to narrow during the two weeks prior to the election. Of the total 127 observations conducted for the 2008 presidential election, the prediction markets outperform the polls 94 percent of the time.<sup>17</sup> Moreover, during the period of more than 120 days before the election, the prediction markets outperform the polls 71 percent of the time.<sup>18</sup> For the period of 81-120 days before the election, the percentage rises to 90 percent; during the period of 41-80 days before the election, the percentage

<sup>16</sup> According to binominal tests of the relative accuracy of the prediction markets and daily polls in the 2008 presidential election, the  $p$ -value (1 sided) is 0.000.

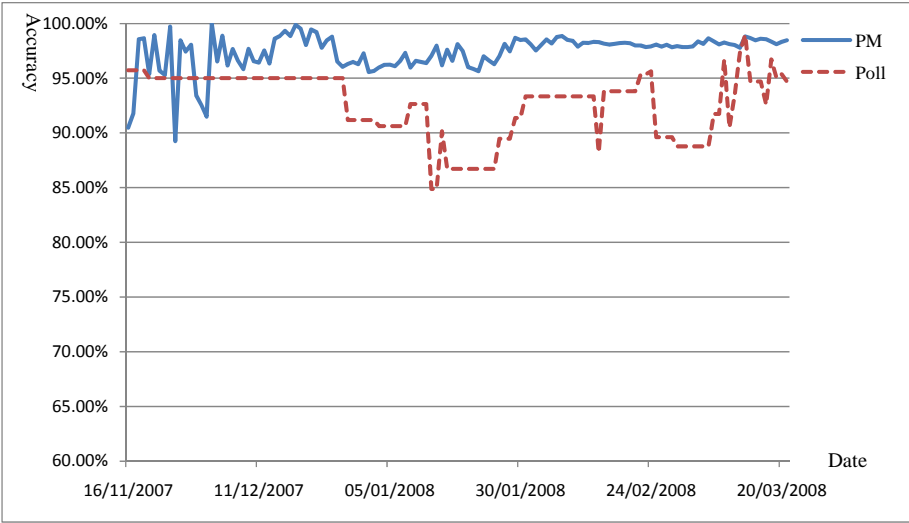
<sup>17</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the polls in the 2008 presidential election, the  $p$ -value (1 sided) is 0.000.

<sup>18</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the polls in the 2008 presidential election, the  $p$ -value (1 sided) is 0.227.

COMPARING THE FORECASTING ACCURACY OF PREDICTION MARKETS AND  
POLLS FOR TAIWAN'S ELECTIONS

maximizes at 100 percent.<sup>19</sup> For the period of 1-40 days before the election, the percentage is 98 percent.<sup>20</sup> These facts suggest that the closer the election date, the higher the normalized accuracy of the prediction markets when compared with the polls.

**FIGURE 9: The normalized accuracy of the polls against that of the prediction markets on a daily basis in the 2008 presidential election**



**CONCLUSION**

By studying the 2006 mayoral elections in Taipei and Kaohsiung and the 2008 presidential election in Taiwan, this paper finds that the accuracy of the prediction markets is higher than that of the polls. In terms of the last forecast before the election date, the accuracy of the prediction markets is 3 to 10 percent higher than that of the polls. When comparing the accuracy of various historical forecasts, the prediction markets outperform the polls in 93 to 100 percent of the cases. Moreover, the average accuracy of the prediction markets is 9 to 10 percent higher than the polls, with a standard deviation of more than 2 percent less than the polls. We therefore conclude that when compared with the polls, the prediction markets not only have a higher accuracy in forecasting elections, but also provide accurate predictions at an earlier stage

<sup>19</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the polls in the 2008 presidential election, the *p*-value (1 sided) is 0.000.  
<sup>20</sup> According to binominal tests of the relative normalized accuracy of the prediction markets and the polls in the 2008 presidential election, the *p*-value (1 sided) is 0.000.

of the election. Furthermore, the standard deviation for the accuracy of the prediction markets is lower than that of the polls.

The prediction markets successfully pass the two robust tests, showing a significantly better accuracy than the polls. When predicting the above two elections, the prediction markets outperform the polls in 86 to 100 percent of the cases on a daily basis. For normalized accuracy, the prediction markets outperform the polls in 79 to 100 percent of the cases (see Table 10).

**TABLE 10: Comparison of prediction accuracy between prediction markets and opinion polls**

	Item	2006 Taipei mayoral election	2006 Kaohsiung mayoral election	2008 presidential election
Three comparisons of accuracy	Last forecast prior to the election	PM is higher than OP by more than 10%	PM is higher than OP by more than 3%	PM is higher than OP by more than 7%
	Historical forecasts	The ratio of PM beating OP is 100%	The ratio of PM beating OP is 93%	The ratio of PM beating OP is 100%
	Average accuracy and standard deviation	The average accuracy of PM is higher than OP by more than 10%; the standard deviation of PM is lower than OP by almost 2%	The average accuracy of PM is higher than OP by more than 9%; the standard deviation of PM is lower than OP by more than 2%	The average accuracy of PM is higher than OP by more than 9%; the standard deviation of PM is lower than OP by more than 2%
Two robust tests	Daily forecast	The ratio of PM beating OP is 100%	The ratio of PM beating OP is 86%	The ratio of PM beating OP is 100%
	Normalized accuracy	The ratio of PM beating OP is 100%	The ratio of PM beating OP is 79%	The ratio of PM beating OP is 94%

Note “PM” is the accuracy of prediction markets; “OP” is the accuracy of opinion polls.

Despite the tests of accuracy between the prediction markets and polls presented here are slanted in favor of markets, a race between polls which capture current opinion or preference and markets which are inherently



forward looking is not a fair race. While the polls with a modification or modeled process may possibly outperform the prediction markets (Erikson and Wlezien 2008), these data are not available in public and polls are still the most commonly used methods to predict election results in Taiwan. As a result, it is worthwhile and justified (not necessarily fair) to compare the forecasting accuracy of prediction markets and polls in terms of predicting election results. In addition, even a modified or modeled polls might be more accurate than prediction markets in some cases, the prediction markets are still considered an effective mechanism for predicting election results, especially taking into account the fact that prices in the markets can very accurately predict the election results on a real time basis.

To summarize, the prediction markets have a far better accuracy in these two elections in a young East Asian democracy of Taiwan, as compared with the unweighted poll results. It is expected that in the future more studies will be conducted to verify whether the prediction markets can also outperform the polls in other elections, to identify the factors that may affect the accuracy of the prediction markets, and to calculate the confidence level of prediction results. We believe these future studies will enable us to use this instrument confidently for the prediction of election results. (Berg, Nelson and Rietz 2003)

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