Forecasting: Intentions, Expectations, and Confidence

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- Yahoo! Research, Economist

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Forecasts: Individual-Level Information

- Gather information from individuals, analyze it, and aggregate that information into forecasts of upcoming events.
- Make forecasts more efficient.
- Make forecasts more versatile.
- Make forecasts more economically efficient.

Two Methods of Aggregating Individual-Level Information into Forecast: Polls *versus* Prediction Markets

- Sample Selection: random sample of representative group *versus* self-selected group
- Question: intention *versus* expectation
- Aggregation: average *versus* weighted by money (proxy for confidence)
- Incentive: not incentive compatible *versus* incentive compatible

Article 1 … Forecasting Elections: Voter Intention versus Expectation

- When polling individuals in order to forecast an upcoming election, which question creates a more efficient and versatile forecast?
  - Voter Intention: Who would you vote for if the election were held today?
  - Voter Expectation: Who do you think will win the election?
- Motiving Idea:
  - Intention: individual
  - Expectation: individual, social network, central signal

Forecasting the President

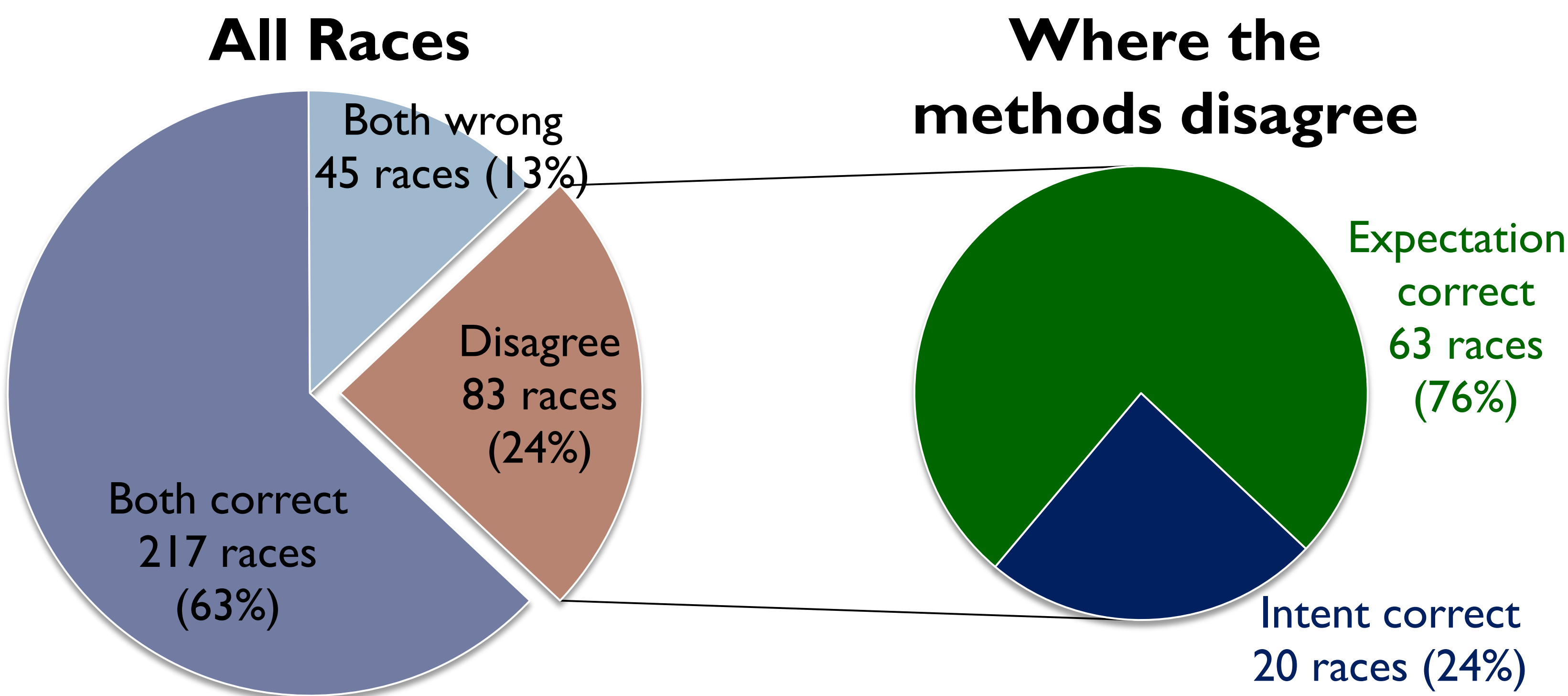
Year	Race	Actual result: % voting for winner
1952	Eisenhower beat Stevenson	55.4%
1956	Eisenhower beat Stevenson	57.8%
1960	Kennedy beat Nixon	50.1%
1964	Johnson beat Goldwater	61.3%
1968	Nixon beat Humphrey	50.4%
1972	Nixon beat McGovern	61.8%
1976	Carter beat Ford	51.1%
1980	Reagan beat Carter	55.3%
1984	Reagan beat Mondale	59.2%
1988	GHW Bush beat Dukakis	53.9%
1992	Clinton beat GHW Bush	53.5%
1996	Clinton beat Dole	54.7%
2000	GW Bush beat Gore	49.7%
2004	GW Bush beat Kerry	51.2%
2008	Obama beat McCain	53.7%

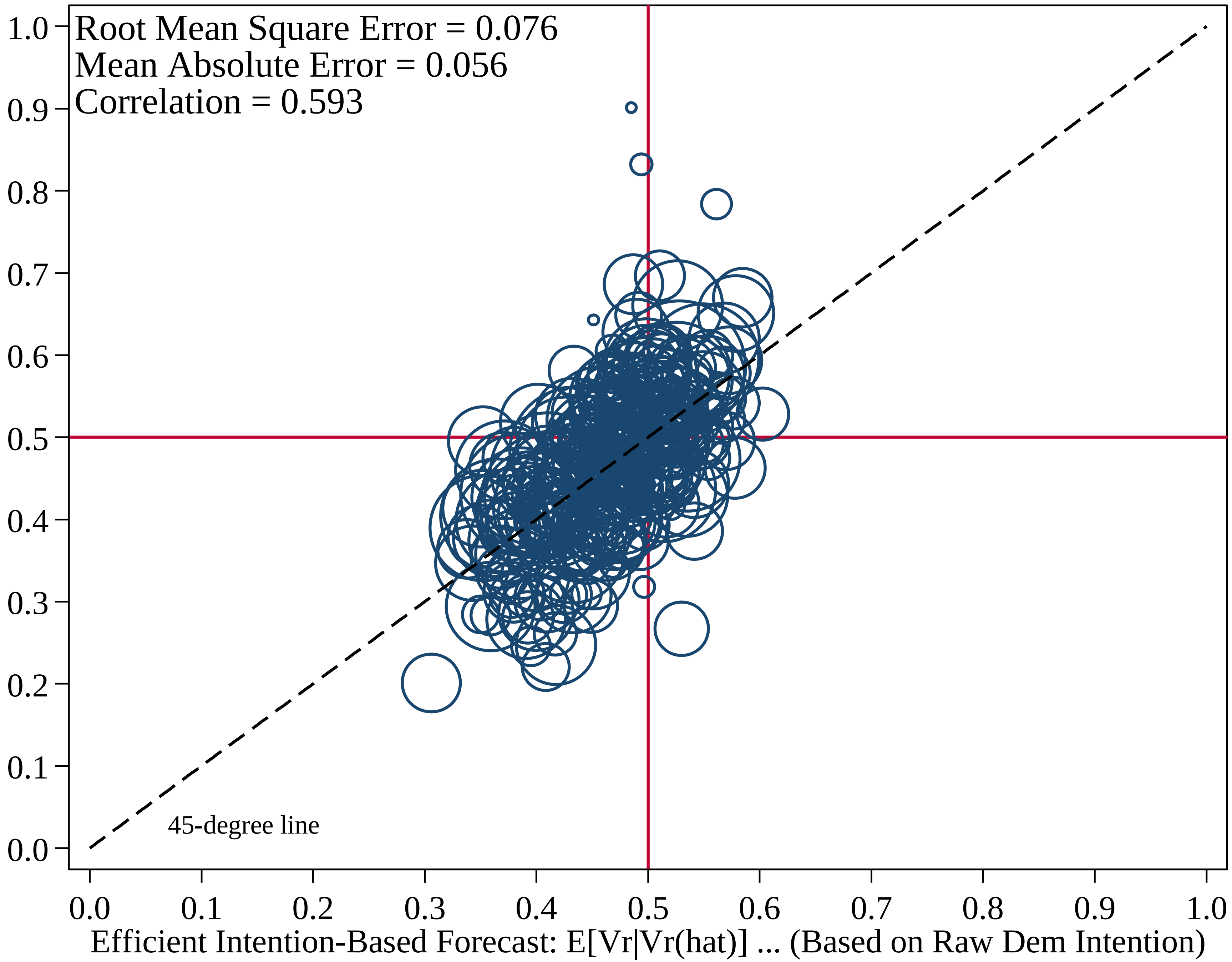
Contribution 1: Expectations Possess Untapped Information

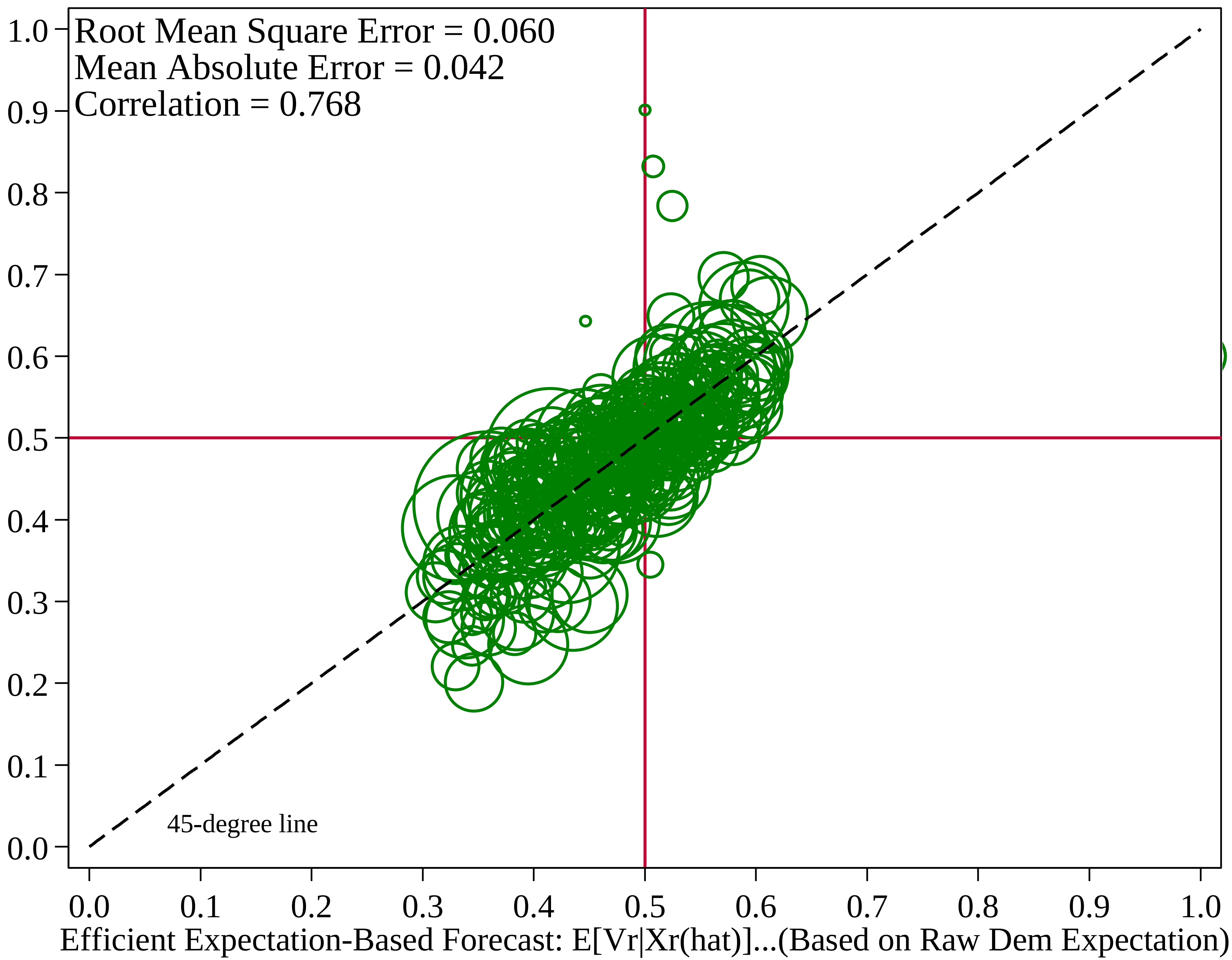
- Expectation question forecasts winner more often and translates into estimated vote share and probability of victory with more accuracy.
- Rothschild (2009)
- Rhode & Strumpf (2004) and Alford (1977)

Predicting the winner of a state's electoral college

- The winner was picked by a majority of respondents to the question on:
  - Voter intentions: in 239 / 345 races = 69%
  - Voter expectations: in 279 / 345 races = 81%
  - Difference in proportions: z=3.52***




Root Mean Square Error = 0.076
Mean Absolute Error = 0.056
Correlation = 0.593
45-degree line
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Efficient Intention-Based Forecast: E[Vr|Vr(hat)] ... (Based on Raw Dem Intention)



Root Mean Square Error = 0.060
Mean Absolute Error = 0.042
Correlation = 0.768
45-degree line
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Efficient Expectation-Based Forecast: E[Vr|Xr(hat)]...(Based on Raw Dem Expectation)

Forecast of Vote Share

	Efficient Voter Intention: $E[v_r \mid \widehat{v_r}]$	Efficient Voter Expectation: $E[v_r \mid \widehat{x_r}]$	Test of Equality
Root Mean Squared Error	0.076 (0.005)	0.060 (0.006)	$t_{310}=5.75$ ($p<0.0001$)
Mean Absolute Error	0.056 (0.003)	0.042 (0.002)	$t_{310}=6.09$ ($p<0.0001$)
How often is forecast closer?	37.0% (2.6)	63.0% (2.6)	$t_{310}=4.75$ ($p<0.0001$)
Correlation	0.593	0.768	
Encompassing regression: $v_r = \alpha + \beta_v Intention_r + \beta_x Expectation_r$	0.184** (0.089)	0.913*** (0.067)	$F_{1,308}=25.5$ ($p<0.0001$)
Optimal weights: $v_r = \beta Intention_r + (1-\beta) Expectation_r$	9.5% (6.7)	90.5%*** (6.7)	$F_{1,310}=36.7$ ($p<0.0001$)

Notes: ***, **, and * denote statistically significant coefficients at the 1%, 5%, and 10%, respectively. (Standard errors in parentheses). These are assessments of forecasts of the Democrat's share of the two-party vote in n=311 elections. Comparisons in the third column test the equality of the measures in the first two columns. In the encompassing regression, the constant $\hat{\alpha} = -0.046$ (se=0.030).

2008 Data

Forecast of Vote Share:	Efficient Voter Intention: $E[v_r \mid \widehat{v_r}]$	Efficient Voter Expectation: $E[v_r \mid \widehat{x_r}]$	Test of equality
Root Mean Squared Error	0.093	0.085	$t_{33}=1.28$ ($p<0.2105$)
Mean Absolute Error	0.063	0.056	$t_{33}=0.92$ ($p<0.3656$)
How often is forecast closer?	47.1%	52.9%	$t_{33}=0.34$ ($p<0.7371$)
Correlation	61.6%	69.2%	
Encompassing regression: $v_r = \alpha + \beta_v Intention_r + \beta_x Expectation_r$	0.330 (0.291)	0.684*** (0.250)	$F_{1,31}=0.49$ ($p<0.4891$)
Optimal weights: $v_r = \beta Intention_r + (1-\beta) Expectation_r$	24.7% (26.7)	75.3%*** (26.7)	$F_{1,33}=0.89$ ($p<0.3519$)
Probabilistic Forecasts:	$Prob(v_r > 0.5 \mid \widehat{v_r})$	$Prob(v_r > 0.5 \mid \widehat{x_r})$	
Root Mean Squared Error	0.458	0.403	$t_{344}=1.55$ ($p<0.1295$)
How often is forecast closer?	23.5%	76.5%	$t_{344}=3.58$ ($p<0.0011$)
Encompassing regression: $I(DemWin)_r = \Phi\left(\alpha + \beta_v \Phi^{-1}(Prob_I) + \beta_x \Phi^{-1}(Prob_x)\right)$	1.618 (1.289)	1.224** (0.520)	$\chi^2=0.07$ ($p<0.7952$)
Optimal weights: $I(DemWin)_r = \Phi\left(\beta \Phi^{-1}(Prob_I) + (1-\beta)\Phi^{-1}(Prob_x)\right)$	2.4% (39.1)	97.6%** (39.1)	$\chi^2=0.28$ ($p<0.5989$)

Forecast of Winner (Out of Sample)

	Days Before the Election ≤ 90				90 < Days Before the Election ≤ 180				Days Before the Election > 180			
	Proportion of observations where the winning candidate was correctly predicted by a majority of respondents by:											
	Exp	**Int**	**Obs**	**Elec**	**Exp**	**Int**	**Obs**	**Elec**	**Exp**	**Int**	**Obs**	**Elec**
President	89%	81%	161	19	69%	62%	39	12	60%	58%	52	11
1936 E-C	72%	81%	47	47	-	-	0	0	-	-	0	0
Governor	79%	79%	19	9	83%	50%	6	6	100%	100%	2	1
Senator	82%	91%	11	7	-	-	0	0	-	-	0	0
Mayor	100%	100%	4	2	100%	67%	3	1	-	-	0	0
Other	85%	81%	10	9	100%	67%	3	2	50%	50%	2	2
USA Total	85%	81%	252	93	75%	61%	51	21	61%	59%	56	14

Forecast of Winner (Out of Sample)

	Days Before the Election ≤ 90				90 < Days Before the Election ≤ 180				Days Before the Election > 180			
	Proportion of observations where the winning candidate was correctly predicted by a majority of respondents by:											
	Exp	**Int**	**Obs**	**Elec**	**Exp**	**Int**	**Obs**	**Elec**	**Exp**	**Int**	**Obs**	**Elec**
AUS	89%	42%	36	3	67%	33%	21	3	24%	66%	86	2
GBR	85%	90%	20	9	100%	92%	13	7	69%	63%	62	9
FRA	61%	57%	23	4	40%	20%	5	3	-	-	0	0
Other	71%	71%	7	6	0%	0%	1	1	0%	0%	1	1
Non-USA Total	79%	59%	86	22	73%	50%	40	14	43%	64%	149	12

Contribution 2: Expectation Response Contains Information of Others

- Structural interpretation of the response shows it to be the equivalent of a multi-person poll.
- Response has a lot information about social network.
- Granberg and Brent (1983)

Structural Interpretation

- Each of us runs a "private poll" of *m-1* friends and family
  - Also include yourself in this poll
- Proportion of your social network intending to vote Democrat

$$s_r^i \sim Binomial(v_r, \frac{v_r(1-v_r)}{\mathrm{m}})$$

- Probability i expect the Democrat to win

$$Prob\left(s_r^i > 0.5\right) = \Phi\left(\frac{v_r - 0.5}{\sqrt{\frac{v_r(1-v_r)}{m}}}\right) \approx \Phi(2\sqrt{m}(v_r - 0.5))$$

  - Using the normal approximation to binomial distribution
  - And $1/\sqrt{v_r(1-v_r)} \approx 2$ in competitive races
- Probit regression of expectations on vote share yields:
  - $\widehat{m} = 11.1$ (se=1.1, clustering by state-year)

Social Circles Are Not Representative

- If your social circles has a known partisan bias
  - Probability that someone in your social circle votes Democrat

    $v_r + \theta_r^{s_i}$ where $\theta_r^{s_i}$ is the bias in your social circle
  - Your expectations can "de-bias"

$$E\left[v_r \middle| \widehat{v_r^i}; \theta_r^{s_i}\right] = \widehat{v_r^i} - \theta_r^{s_i}$$

  - Thus these expectations:

$$\widehat{v_r^i} \sim \mathrm{Binomial}(v_r, (v_r + \theta_r^{s_i})(1 - v_r - \theta_r^{s_i})/m)$$

  - You expect the Democrat to win if:

$$Prob\left(v_r + \eta_r^i > 0.5\right) \approx \Phi\left(2\sqrt{m}(v_r - 0.5)\right)$$

  - Known partisan bias yields same results as before
    - Because respondents can de-bias

Social Circles with Correlated Shocks

- If your social circle has correlated (but unobserved) shocks:
  - Probability that someone in your social circle votes Democrat

$$v_r + \eta_r^i \text{ where } \eta_r^i \sim N(0, \sigma_\eta^2)$$

  - Thus the result of your informal poll of $m' - 1$ friends:

$$\widehat{v_r^i} \sim N\left(v_r, \frac{v_r(1-v_r)}{m\prime}\left[1 + (m' - 1)\frac{\sigma_\eta^2}{v_r(1-v_r)}\right]\right)$$

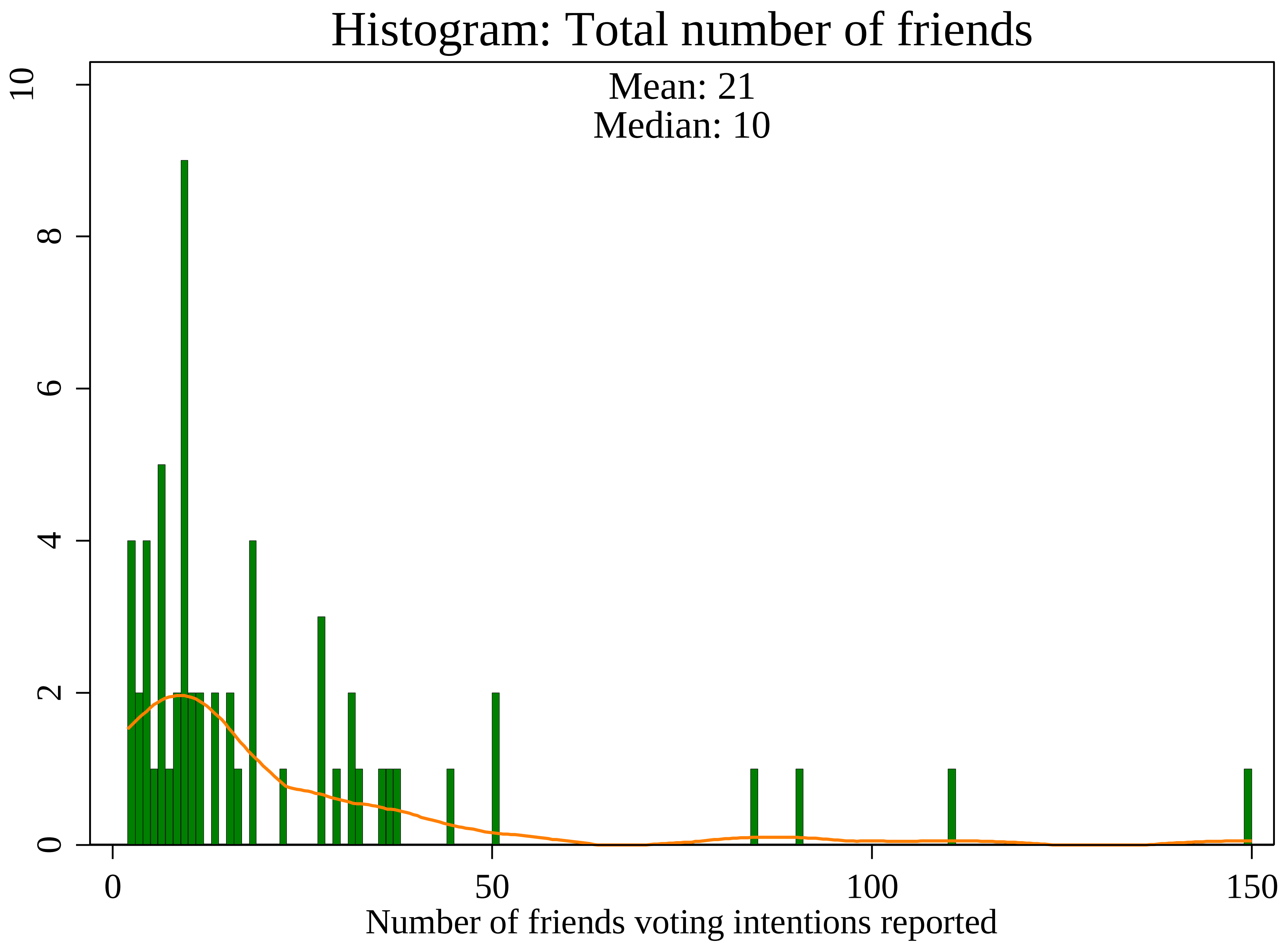
  - You expect the Democrat to win if:

$$Prob\left(v_r + \eta_r^i > 0.5\right) \approx \Phi\left(\frac{2\sqrt{m'}}{\sqrt{1 + 4(m' - 1)\sigma_\eta^2}}(v_r - 0.5)\right)$$

  - Implies an equivalence between m randomly-sampled friends and $m' = m\frac{1-4\rho_i^x\sigma_\epsilon^2}{1-4\sigma_\epsilon^2 m}$ with correlated views
    If $\sigma_\eta^2 = 0\ and\ m = 11 \Leftrightarrow \sigma_\eta^2 = 0.5\sigma_\epsilon^2\ and\ m' = 21$

A Pilot Survey (with Gallup)

- *Next, I would like you to consider the friends, family members and co-workers with whom you regularly discuss politics on a regular basis and who are likely to vote in the Republican primary for president in New Hampshire next year. As I read each name, please tell me <u>how many</u> of your friends, family members and co-workers are likely to support that candidate in the New Hampshire primary. Just your best guess will do. **[IF NECESSARY, READ:** We are looking for the total number of people you know who would likely support the candidate] **[READ AND ROTATE A-J]***
- Pilot: *n=81* in New Hampshire, Iowa, Nevada and South Carolina


Histogram: Total number of friends
Mean: 21
Median: 10
0
2
4
6
8
10
0
50
100
150
Number of friends voting intentions reported

Correlated Beliefs within Social Circles

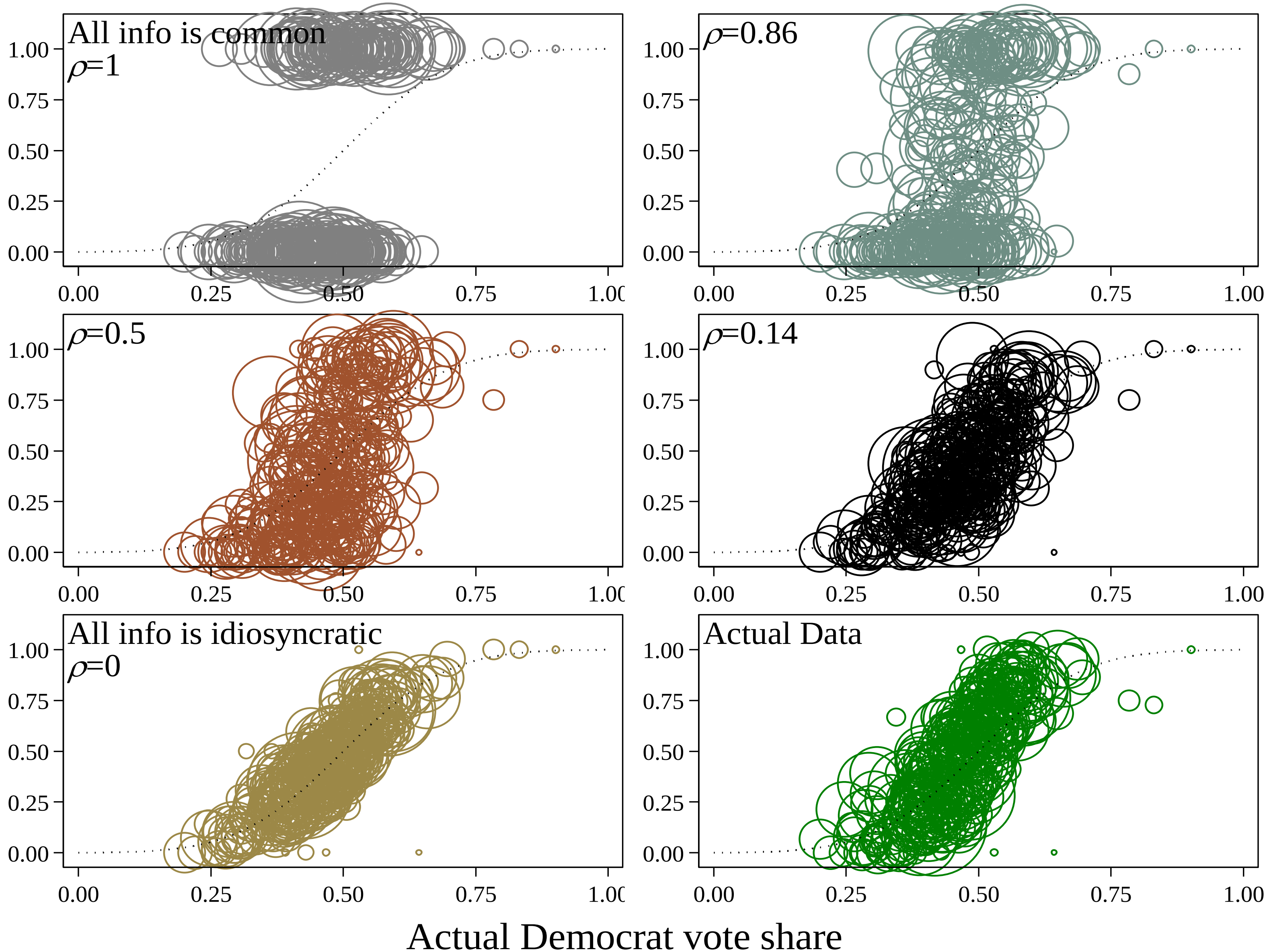
- 2000 National Election Studies Social Network module:
  - *"From time to time, people discuss government, elections and politics with other people. I'd like to ask you about the people with whom you discuss these matters. These people might or might not be relatives. Can you think of anyone?"*
  - *"How do you think [name] voted in the election?"*
- Estimate a random effects model:

$$I\left(v_r^i = 1\right) = r_r + \eta_r^{s_i} + \zeta_r^i$$

Vote Democrat = election-specific constant + social circle random effect + idiosyncratic influences

- Yields: $\widehat{\sigma_\eta^2} = 0.110$ and $\widehat{\sigma_\zeta^2} = 0.137$
- Which implies: $\hat{m} = 19.2$

Extent of Disagreement



What Info is Being Aggregated

- Are voter expectations a function of:
  - Idiosyncratic information about your social circle; OR
  - Common information across respondents?
- Three approaches:

1. Accuracy and sample size
   - Typically accuracy is a function of $\sqrt{n}$
   - But if we each have m respondents to our own informal polls then accuracy is a function of $\sqrt{mn}$
2. Results of pilot survey
3. Extent of disagreement
   - Formally, a random effects probit model of voter expectations

- Preliminary findings: All three approaches suggest common information is a minor influence
  - Each respondent has the equivalent of about 10-20 friends

Correlation: Intent and Expectation

Intentions	Expectations: Expect Democrat to win this state	Expectations: Expect Republican to win this state
Intend to vote Democrat	33.9% (68.8%) [71.2%]	15.4% (31.2%) [29.3%]
Intend to vote Republican	13.7% (27.0%) [28.8%]	37.1% (73.0%) [70.7%]

Raw proportions; (% of row in parentheses); [%of column in square brackets]

- Correlation between people's intentions and expectations = 0.42
- 70.9% of people expect their candidate to win
- Psychologists: Wishful thinking
- Political scientists: Bandwagon effects
- My argument: Rational inference based on limited info

Correlation: Intent and Expectation

- Recall that I am one of *m* observations in my own poll
  - Creates a correlation between voter expectations and intentions
- Probability a **Democrat** expects the Democrat to win:

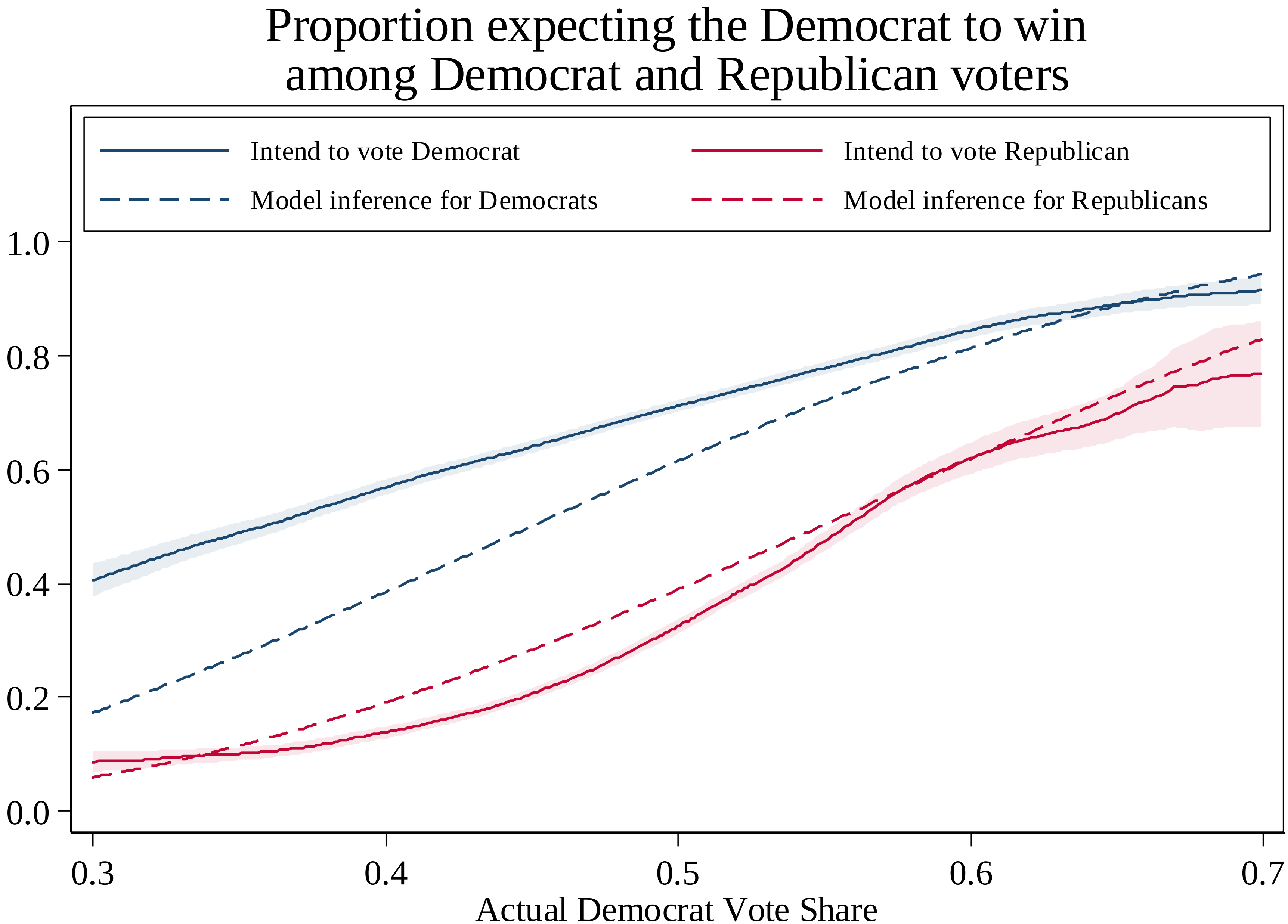
$$Prob\left(\mathbf{1} + (m-1)v_r > \frac{m}{2}\right) \approx \Phi\left(\frac{\frac{1}{m} + \frac{m-1}{m}v_r - 0.5}{\sqrt{\frac{v_r(1-v_r)}{m-1}}}\right)$$

$$\approx \Phi\big(5.8(v_r - 0.45)\big)$$

  - Using normal approximation (ignoring ties)
  - And $m=11.1$
- Probability a **Republican** expects the Democrat to win:

$$Prob\left(\mathbf{0} + (m-1)v_r > \frac{m}{2}\right) \approx \Phi\left(\frac{\frac{m-1}{m}v_r - 0.5}{\sqrt{\frac{v_r(1-v_r)}{m-1}}}\right)$$

$$\approx \Phi\big(5.8(v_r - 0.55)\big)$$

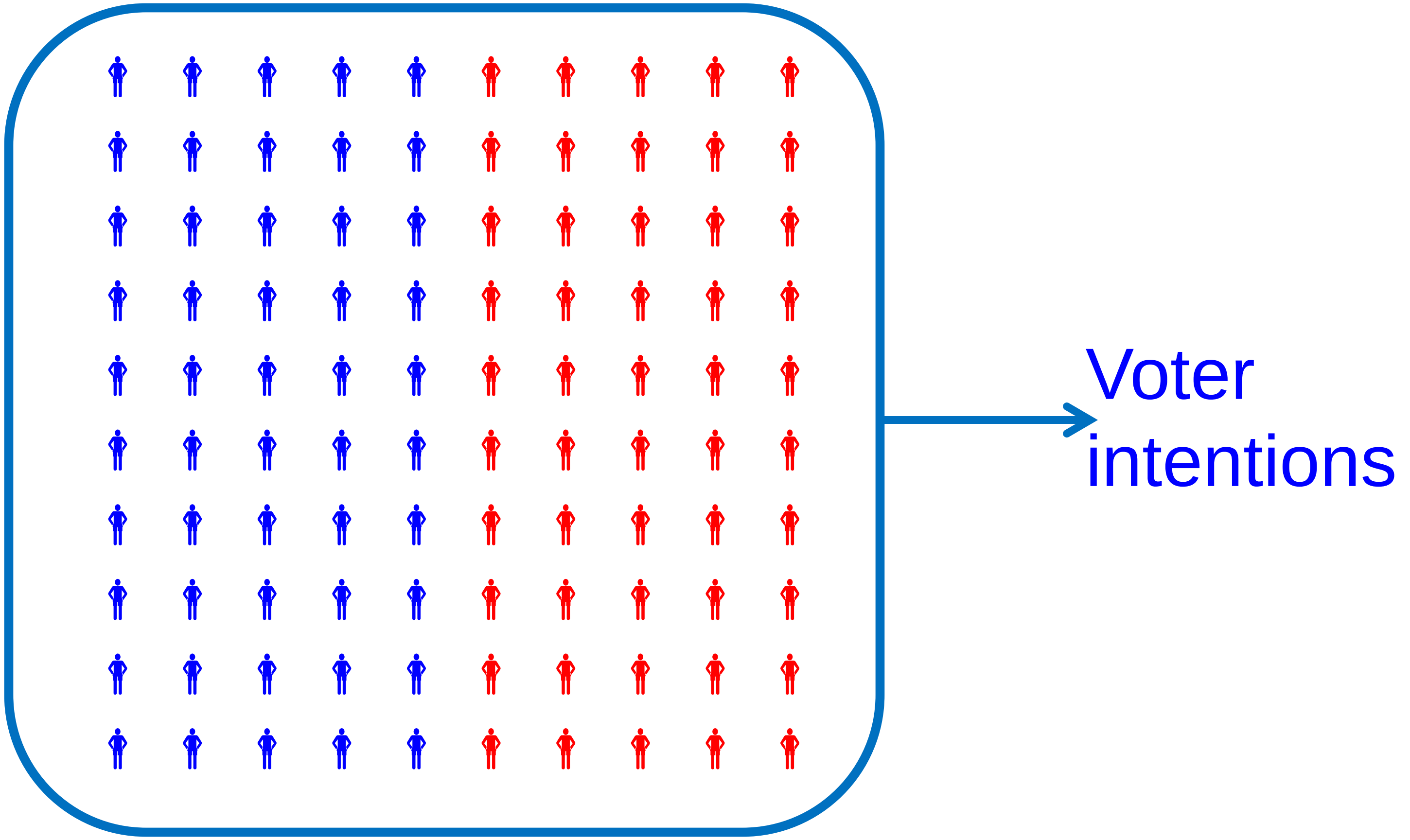


Local linear regression estimates, using Epanechnikov kernal and rule-of-thumb bandwidth.
Shaded area shows 95% confidence interval.

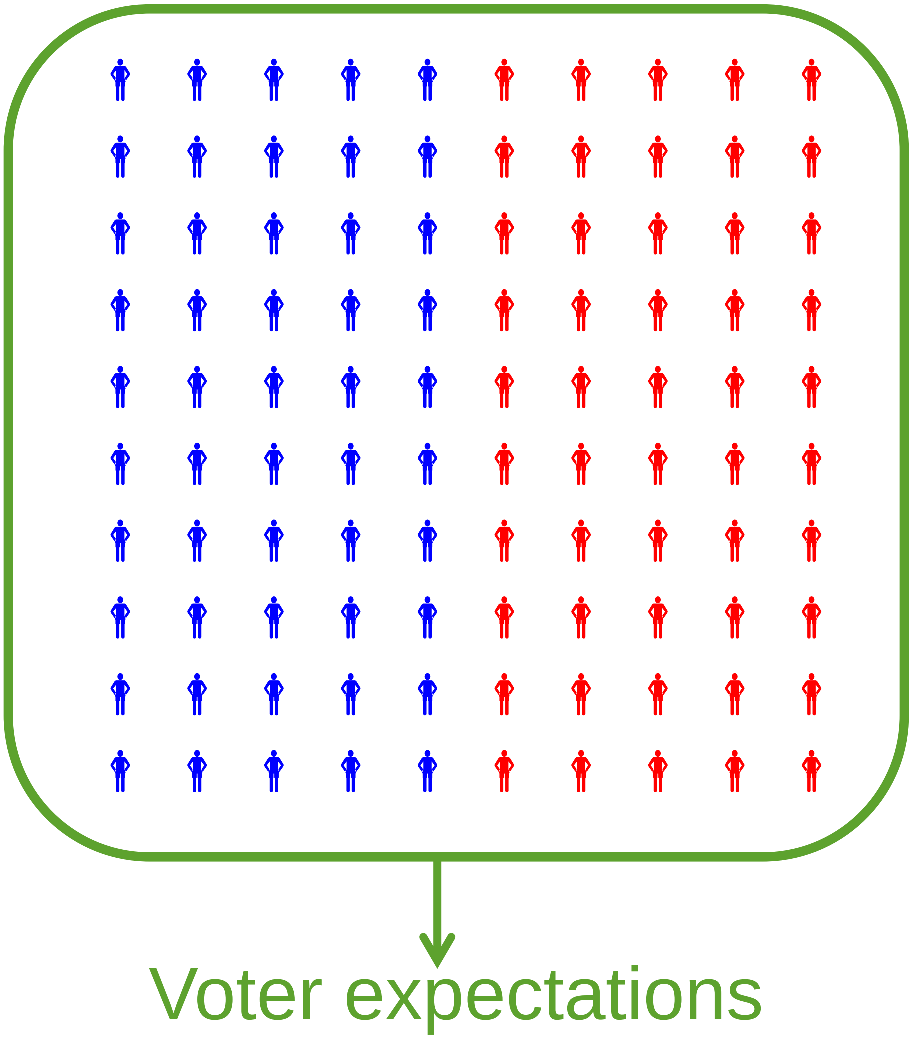
Contribution 3: Sample Selection

- Expectation-based forecasts from just those who intend to vote Democratic, or just Republican, are more accurate than the forecasts based on the full intention data.
- Importance: declining landline penetration, unrepresentative online survey, difficulty in contacting working families.
- Robinson (1937)
- Berg & Rietz (2006)

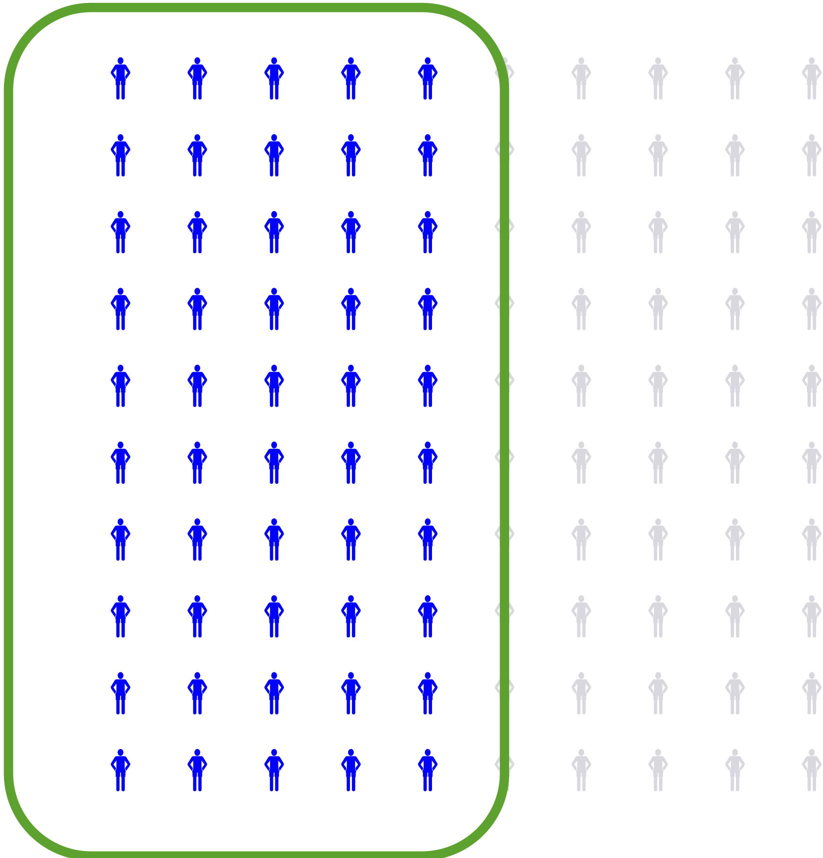
Standard Intentions-Based Forecast



Expectation-Based Forecast



Biased Expectation-Based Forecast



Account for correlation between intentions and expectations

Expectations-based forecast using only Democrats

	Democratic Sample		Republican Sample	
Forecast of Vote Share:	$E[v_r \mid \widehat{v_r}]$	$E[v_r \mid \widehat{x_r}]$	$E[v_r \mid \widehat{v_r}]$	$E[v_r \mid \widehat{x_r}]$
Root Mean Squared Error	0.075 (0.005)	0.070 (0.006)	0.071 (0.004)	0.062 (0.004)
Mean Absolute Error	0.056 (0.003)	0.050 (0.003)	0.054 (0.003)	0.048 (0.002)
How often is forecast closer?	46.7% (2.9)	53.3% (2.9)	44.0% (2.8)	56.0% (2.8)
Correlation	0.592	0.664	0.604	0.718
Encompassing regression: $\boldsymbol{v_r = \alpha + \beta_v Intention_r + \beta_x Expectation_r}$	0.625*** (0.078)	0.790*** (0.071)	0.489*** (0.077)	0.786*** (0.065)
Probabilistic Forecasts:	$\boldsymbol{Prob(v_r > .5 \mid \widehat{v_r})}$	$\boldsymbol{Prob(v_r > .5 \mid \widehat{x_r})}$	$\boldsymbol{Prob(v_r > .5 \mid \widehat{v_r})}$	$\boldsymbol{Prob(v_r > .5 \mid \widehat{x_r})}$
Root Mean Squared Error	0.444 (0.006)	0.388 (0.010)	0.442 (0.006)	0.357 (0.013)
How often is forecast closer?	28.4% (2.6)	71.5% (2.6)	19.9% (2.3)	80.1% (2.3)
Encompassing regression: $\boldsymbol{I(DemWin)_r = \Phi\left(\alpha + \beta_v \Phi^{-1}(Prob_I) + \beta_x \Phi^{-1}(Prob_x)\right)}$	1.73*** (0.40)	1.62*** (0.20)	1.29*** (0.41)	1.53*** (0.17)
	306 Elections		307 Elections	

Notes: ***, **, and * denote statistically significant coefficients at the 1%, 5%, and 10%, respectively. (Standard errors in parentheses).

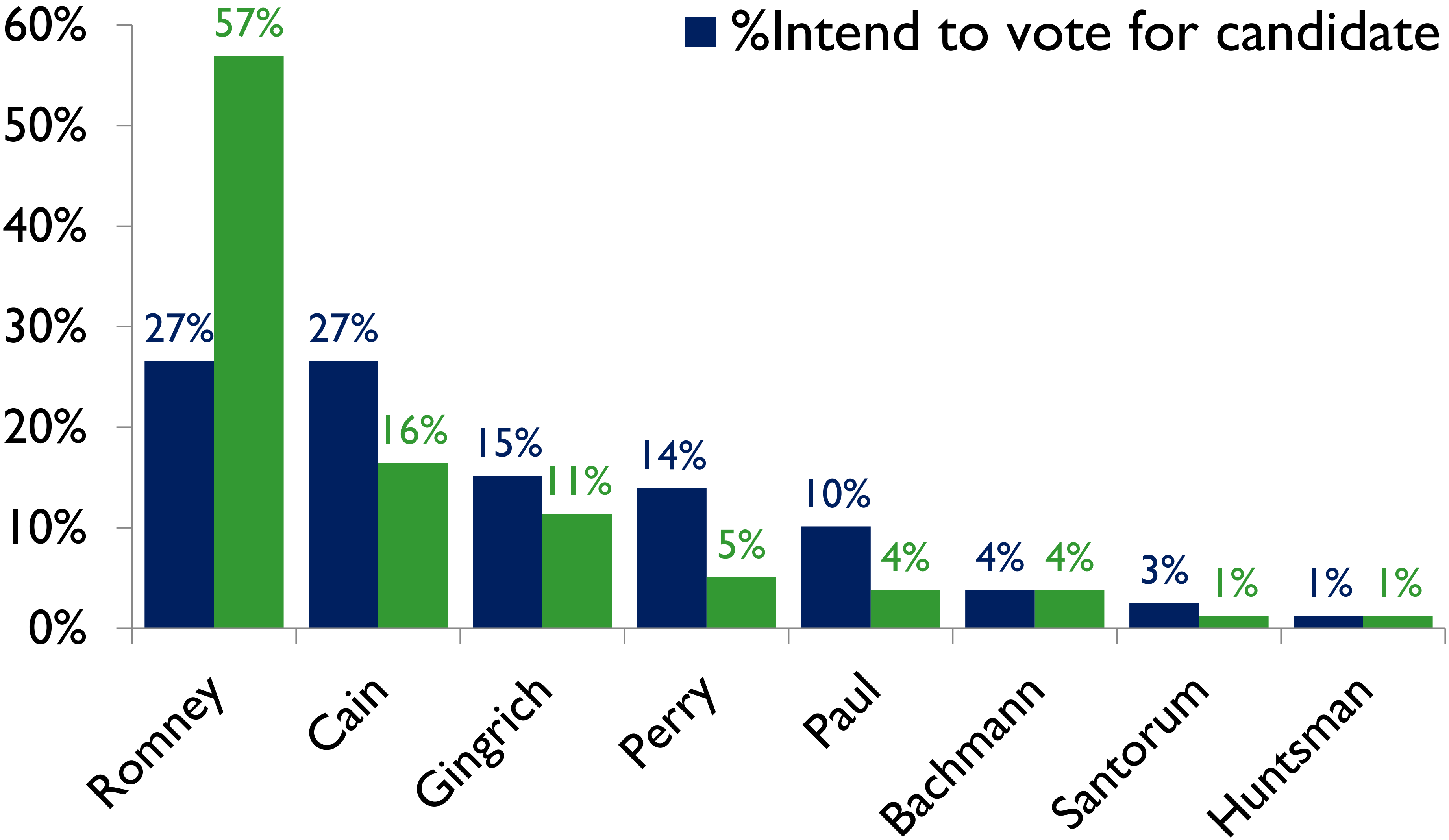
Discussion

- Explore new ways to interact with individuals and gather their information.
- Expand the structural interpretation to cover a national signal and a local signal:
  - Network theory
- Cost-Benefit: non-random samples are becoming much less expensive than random samples; we need to study how to utilize them.

Related Applications

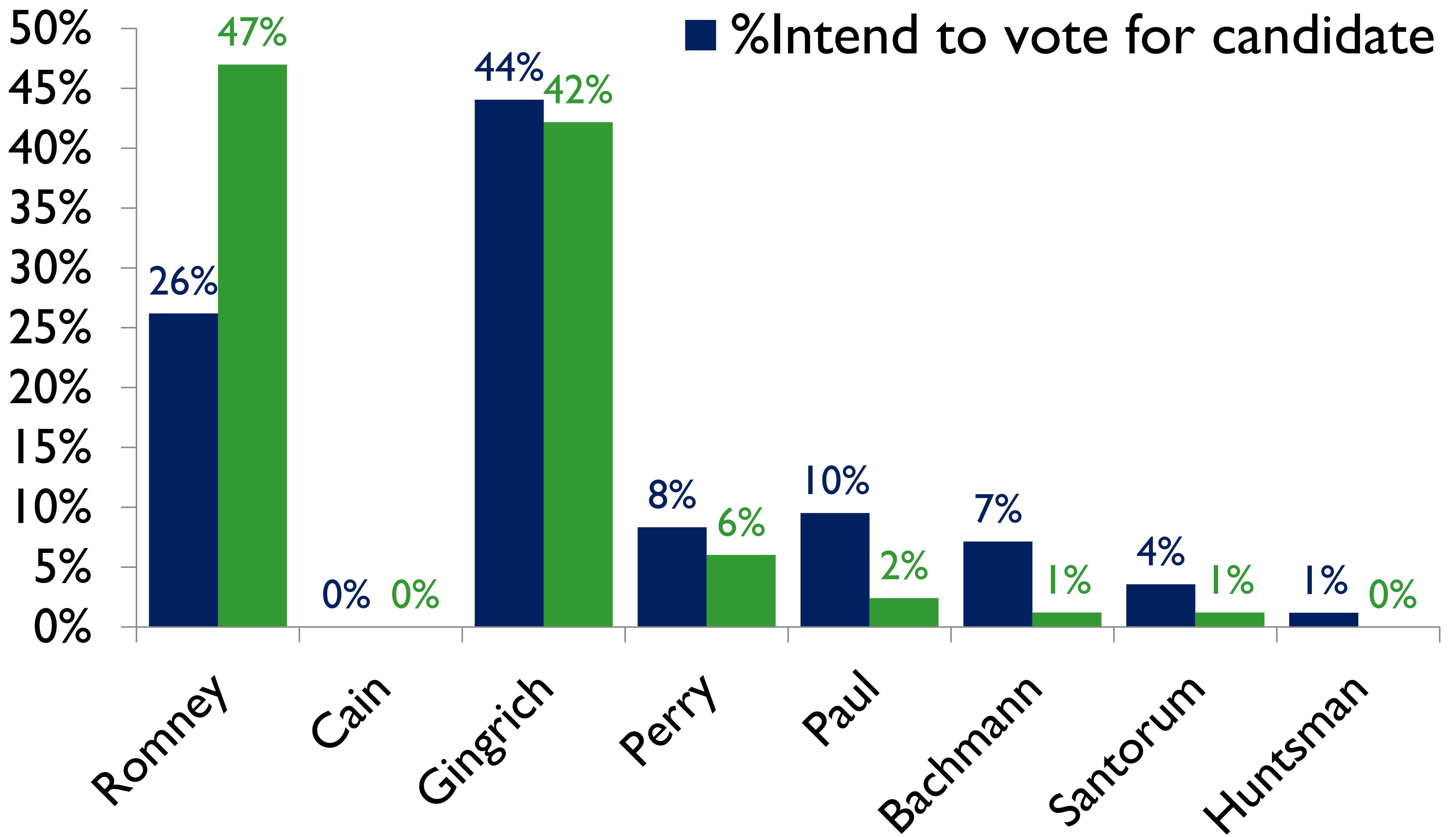
- Low probability events
  - Estimating civilian deaths in war
  - Department of Labor mine safety
- Incentives to deceive
  - Cheating in the NCAA
  - Gays in the military
- Social desirability bias
  - Abortion counts where it is illegal
- Simpler sampling frames
  - Gallup job creation index
- Small sample sizes
  - Marketing and focus groups

2012 Republican Primary



Gallup survey November 2-6, n=1054 Republicans or R-leaning independents

2012 Republican Primary



Gallup survey December 1-5, n=1054 Republicans or R-leaning independents

Article 2 … Expectations: Point-Estimates, Probability Distributions, Confidence and Forecasts

- Can a new method be used to gather previously untapped information from the respondents?
  - Ariely et al. (2003): Coherent Arbitrariness
- Can that new information be used to make more efficient and versatile forecasts than the standard information?

Fast Food Calories

What is your best estimate for the calories in the noted item below?

The below figure shows a picture, a description from the company, and the calories for popular items at national fast food chains. The calories of one item have been randomly dropped by the computer.

A boneless breast of chicken season to perfection, hand-breaded, pressure cooked in 100% refined peanut oil and served on a toasted, buttered bun.

Strawberry frosted donut.

Buttermilk biscuit topped with a fried egg, American cheese and bacon.

Get ready for two steakburgers with American and Swiss cheeses, on buttery, grilled sourdough with our sweet 'n tangy frisco sauce.

We start with our irresistible, real dairy Frosty and add coffee syrup made with real-brewed coffee. Then we mix in chocolate-covered toffee candy made in old-fashioned copper kettles to create a rich, indulgent treat.

100% pure American beef with mustard, lettuce, tomatoes, pickles and onions.

550 Calories

Continue...

Fast Food Calories

Think about the range of values that the calories may be. Please use the +/- keys below to fill up the 9 available bins so that they reflect the likelihood that the calories of the food or drink will fall in the range represented by each bin.

A boneless breast of chicken season to perfection, hand-breaded, pressure cooked in 100% refined peanut oil and served on a toasted, buttered bun.

430 Cal

800 Cal

Get ready for two steakburgers with American and Swiss cheeses, on buttery, grilled sourdough with our sweet 'n tangy frisco sauce.

Strawberry frosted donut.

230 Cal

540 Cal

We start with our irresistible, real dairy Frosty and add coffee syrup made with real-brewed coffee. Then we mix in chocolate-covered toffee candy made in old-fashioned copper kettles to create a rich, indulgent treat.

Buttermilk biscuit topped with a fried egg, American cheese and bacon.

423 Cal

Estimate this Item!

100% pure American beef with mustard, lettuce, tomatoes, pickles and onions.

239 Cal

Amount Left to Distribute: 22%

0%	0%	0%	20%	28%	20%	10%	0%	0%
- +	- +	- +	- +	- +	- +	- +	- +	- +
0 to 343.5	343.5 to 402.5	402.5 to 461.5	461.5 to 520.5	520.5 to 579.5	579.5 to 638.5	638.5 to 697.5	697.5 to 756.5	756.5 to Infinity

Calories for the Food or Drink

Continue...

Data

- Five categories of questions
- 9 or 10 unique questions
- Respondent gets 1 randomly assigned question per category and categories are in random order
- Respondents: Wharton Behavioral Lab and Mechanical Turk
- Study 1: half standard method and half confidence ranges / stated confidence
- Study 2: half standard incentive and half incentive compatible

Contribution 1: Revealed Confidence Positively Correlated with Accuracy of Expectations.

- Revealed confidence from the probability distributions demonstrates a sizable and statistically significant positive correlation with the accuracy accompanying expectation.
- Likert-type Rating Scales:
  - Kuklinski (2000)

Confidence and Accuracy

- Rank error and confidence from smallest to largest in unique question: 0 to 1
- $\text{Rank}(\text{Error}) = \alpha + \beta * \text{Rank}(\sigma)$
- Within Question: OLS
- Within Respondent: fixed-effect for the respondent
- Positive correlation between rank of confidence and rank of accuracy for all three methods
- Most significant and meaningful with full probability distribution

Confidence and Accuracy

	Stated Confidence	Confidence Range	Probability Distribution	R^2
$Rank(Error) = \alpha + \beta * Rank(\sigma)$ **OLS (Within Question)**	0.035 (0.038)	-	-	0.000
	-	0.151*** (0.040)	-	0.023
	0.006 (0.038)	0.150*** (0.041)	-	0.023
	-	-	0.231*** (0.040)	0.053
$Rank(Error) = \alpha + \beta * Rank(\sigma)$ **Fixed-Effect (Within Respondent)**	0.103** (0.050)	-	-	0.001
	-	0.233*** (0.051)	-	0.023
	0.070 (0.050)	0.222*** (0.052)	-	0.022
	-	-	0.260*** (0.052)	0.053

Note: ***, **, and * denote statistically significant coefficients at the 1%, 5%, and 10% level, respectively. (Standard errors in parentheses). The errors and standard deviations are normalized by their rank within the unique question. The stated confidence and confidence range questions were answered by 129 respondents and the probability distribution by 120. There are a total of 48 unique questions in 5 categories; each respondent answered 5 questions, one in each category.

Contribution 2: Forecasts can be confidence-weighted for more accurate point-estimates.

- Weighing the individual-level estimates by their confidence provides a more accurate forecast than standard methods of aggregation.
- Aggregating Forecasts:
  - Simple Aggregation: Bates and Granger (1969), Stock and Watson (2004), Smith and Wallis (2009)
  - Prediction Markets: Rothschild (2009)

Median of Point-Estimate is Most Accurate Standard Consensus Estimate

	Study I	Study II
Categories	5	3
Questions per Category	9.6	10
Observations per Question	25.8	20.1
% of Individual-Level Point-Estimate Absolute Errors < Mean Point-Estimate of Question Absolute Errors	36.7 %	38.8 %
% of Individual-Level Point-Estimate Absolute Errors < Median Point-Estimate of Question Absolute Errors	24.3 %	27.9 %

Note: Point-estimates are all recorded prior to the probability distributions. Study I is randomized between probability distribution method and confidence questions, with 249 respondents. Study II is randomized between flat pay and incentive compatible pay for probability distribution method, with 202 respondents.

Confidence-Weighted Forecasts

- Median of the point-estimates is most efficient forecast from point-estimates.
- On an individual-level, the mean of probability distribution is more accurate than median, mode, or the point-estimate.
- Confidence-weighted forecasts of mean of probability distribution are more accurate than median of point-estimate: $w_i = \frac{1/\sigma_i^2}{\sum_{j=1}^{n} 1/\sigma_i^2}$

Confidence-Weighted Forecasts: Inverse Variance Weights

Category	Weight	Median of Point-Estimate	Confidence-Weighted Mean	Median of Point-Estimate	Confidence-Weighted Mean
		$ans = \alpha + \beta_1 PointEst + \beta_2 ConEst$		$ans = \beta PointEst + (1-\beta) ConEst$	
Calories	$1/\sigma_i^2$	0.059 (0.286)	1.146*** (0.281)	0.052 (0.245)	0.948*** (0.245)
Concert Tickets	$1/\sigma_i^2$	0.730 (0.822)	0.282 (0.677)	0.390 (0.564)	0.610 (0.564)
Gas Prices	$1/\sigma_i^2$	-0.315 (0.398)	-0.021 (0.425)	-0.405 (1.133)	1.405 (1.133)
Movie Receipts	$1/\sigma_i^2$	0.805** (0.319)	-0.791* (0.348)	0.458 (0.453)	0.542 (0.453)
Unemployment	$1/\sigma_i^2$	-1.052 (1.786)	2.097 (1.808)	-0.480 (1.553)	1.480 (1.553)

Note: ***, **, and * denote statistically significant coefficients at the 1%, 5%, and 10% level, respectively. (Standard errors in parentheses). There are 48 question total: 10 for calories, 10 for gas prices, and 10 for unemployment, 9 for concert tickets, and 9 for movie receipts.

Confidence-Weighted Forecasts

R^2 from $ans = \alpha + \beta * Forecast$

Category	R^2 with only Median of Point-Estimate	R^2 with only Confidence-Weighted Forecast	R^2 for Joint Forecast
Calories	0.585	0.884	0.884
Concert Tickets	0.880	0.873	0.882
Gas Prices	0.308	0.347	0.362
Movie Receipts	0.131	0.129	0.534
Unemployment	0.985	0.987	0.988

Note: The confidence-weighted forecast is optimized by category as in the lower half of Table 5. The table is nearly identical regardless of which efficient weighting scheme I utilize.

Hybrid Polls/Prediction Markets w/ Probability Distributions

- What is gained from capturing point-estimates and then probability distributions from non-experts?
- Expectations: the absorption of information into expectations on an individual level.
- Forecasts: create more efficient/versatile forecasts.
- Decisions: test models of individual choice that routinely make strong assumptions about expectations.

Yahoo! Signal

- Experimental Polling
- Experimental Prediction Games
- Prediction Markets, Polls, Fundamentals
- Data Visualizations that non-experts understand
- Articles tie it all together!