

## Overconfidence in Political Behavior<sup>†</sup>

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*This paper studies, theoretically and empirically, the role of overconfidence in political behavior. Our model of overconfidence in beliefs predicts that overconfidence leads to ideological extremeness, increased voter turnout, and stronger partisan identification. The model also makes nuanced predictions about the patterns of ideology in society. These predictions are tested using unique data that measure the overconfidence and standard political characteristics of a nationwide sample of over 3,000 adults. Our numerous predictions find strong support in these data. In particular, we document that overconfidence is a substantively and statistically important predictor of ideological extremeness, voter turnout, and partisan identification. (JEL C83, D03, D72, D83)*

Without heterogeneity in *ideology*—preferences and opinions over political actions—there would be little need for the institutions studied by political economists.<sup>1</sup> However, the sources of ideology have received scant attention: since Marx, political economists have largely viewed ideology as driven by wealth or income—despite the fact that these variables explain little of the variation in ideology (Meltzer and Richard 1981; Frank 2004; Acemoglu and Robinson 2006; Gelman 2009).

This paper proposes a complementary theory in which differences in ideology are also due to imperfect information processing. This theory predicts that *overconfidence* in one's own beliefs leads to ideological extremeness, increased voter

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<sup>1</sup>Without heterogeneity, institutions will still be useful for coordination (Weingast 1997). Traditionally, opinions have not been considered part of ideology; however, recent work has provided compelling arguments that ideology should include some beliefs (McMurray 2013a, b).

turnout, and stronger identification with political parties. Our predictions find strong support in a unique dataset that measures the overconfidence, and standard political characteristics, of a nationwide sample of over 3,000 adults. In particular, we find that overconfidence is the most reliable predictor of ideological extremeness and an important predictor of voter turnout in our data.

By adopting a behavioral basis for ideology, we help answer puzzling questions such as why politicians and voters are becoming more polarized despite the increased availability of information (McCarty, Poole, and Rosenthal 2006), or why political rumors and misinformation, such as “Global warming is a hoax,” are so persistent (Berinsky 2012).<sup>2</sup> Moreover, as behavioral findings deepen our understanding of market institutions (Bertrand 2009; Baker and Wurgler 2013), a behavioral basis for ideology promises greater understanding of the design and consequences of political institutions (Callander 2007; Bisin, Lizzeri, and Yariv forthcoming).

In our model, overconfidence and ideology arise due to imperfect information processing. Citizens passively learn about a state variable through their experiences (signals). However, to varying degrees, citizens underestimate how correlated these experiences are, and thus, have different levels of overconfidence about their information. This underestimation—which we call *correlational neglect*—may have many sources. For example, citizens may choose to get information from a biased media outlet, but fail to fully account for the bias. Indeed, unbeknownst to most users, Google presents different news sources for the same search depending on a user’s location.<sup>3</sup> Alternatively, exchanging information on a social network could lead to correlational neglect if citizens fail to understand that much of the information comes from people similar to themselves, if they fail to recognize the influence of their own previous reports on others’ current reports (DeGroot 1974; DeMarzo, Vayanos, and Zwiebel 2003), or if they fail to account for the presence of rational herds (Eyster and Rabin 2010). Recent laboratory experiments find strong evidence of correlational neglect (Enke and Zimmermann 2013).

Our primary theoretical result is that overconfidence and ideological extremeness are connected. This follows an uncomplicated logic. For example, consider a citizen who notes the number of people in her neighborhood who are unemployed, and uses this information to deduce the state of the national economy. Suppose further that she lives in a neighborhood with high unemployment. If the citizen believes that the employment status of each person is relatively uncorrelated, she will think she has a lot of information about the state of the national economy (that is, she will be overconfident) and favor generous aid to the unemployed and loose monetary policy. If, instead, she realizes that local unemployment has a common cause—say, a factory shutting down—then she will understand that she has comparatively little information about the national economic situation, and

<sup>2</sup>In early 2013, 37 percent of US voters agreed with this statement (Public Policy Polling 2013). Only 41 percent believe global warming is caused by human activity, compared with 97 percent of climate scientists (Yale Project on Climate Change Communication 2013). Similar levels of agreement with other political rumors or “conspiracy theories” are regularly found among voters (Berinsky 2012; Public Policy Polling 2013).

<sup>3</sup>See: <http://vimeo.com/51181384>. Actively seeking information that matches ones’ prior, or ignoring information counter to it, is termed *confirmation bias*. Our model encompasses both of these structures of confirmation bias, but in other settings, such as elections, they may lead to different predictions (Levy and Razin forthcoming).

believe that although the situation is bad, it is not likely to be dire, and will support more moderate policies.

Our data—from the 2010 Cooperative Congressional Election Study (CCES)—strongly supports this prediction. A one standard deviation change in overconfidence is related to 12–28 percent of a standard deviation change in ideological extremeness, depending on the specification. This relationship is as large as, and more stable than, the relationship between extremeness and economic variables. Indeed, the range of correlations for each economic variable includes points that are statistically indistinguishable from zero, suggesting that overconfidence is an important and distinct predictor of ideological extremeness.

The size and complexity of this data allows for the testing of more subtle predictions. For example, if citizens become more conservative when they have more experiences or signals, through aging or media exposure, then overconfidence should be correlated with conservatism. Moreover, extremism should be more correlated with overconfidence for conservatives than liberals. These results find robust support in the data.

To extend this model to voter turnout, we posit an expressive voting model in which the expressive value of voting is increasing with a citizen's belief that one party's policy is better for her (Matsusaka 1995; Degan and Merlo 2011; Degan 2013). Similarly, strength of partisan identification is modeled as the probability a citizen places on her favored party's policy being better for her.

As more overconfident citizens are more likely to believe that one or the other party is likely to have the right policy for them, they are more likely to turn out to vote. This is true even conditional on ideology. The opposite conditional statement also holds: more ideologically extreme citizens are more likely to vote, conditional on overconfidence. Thus, our model matches the well-known empirical regularity that more ideologically extreme citizens are more likely to vote. Similar predictions hold for strength of partisan identification.

This second set of predictions are, once again, robustly supported by the data. Using verified voter turnout data, we document that a one standard deviation change in overconfidence is associated with 7–19 percent increase in voter turnout. This is a more important predictor of turnout in our data than income, education, race, gender, or church attendance.

Finally, we theoretically analyze how our results would be altered by citizens choosing how much (costly) information to acquire, or communicating their ideology to each other. Both of these extensions strengthen our primary results. When citizens can acquire more information, it will be more overconfident citizens that do so. This occurs because more overconfident citizens neglect correlation to a greater degree, and hence believe that additional signals are more valuable. When citizens can communicate, more overconfident citizens will attribute differences in ideology to anything other than their own information being incorrect, and hence update less than less overconfident citizens. Both of these possibilities accentuate the correlation between ideological extremeness and overconfidence.

The remainder of this section provides more details on the behavioral phenomena of overconfidence, connects our work to the literature, and previews the structure of the paper.

### A. *What is Overconfidence?*

Overconfidence describes related phenomena in which a person thinks some aspect of his or hers, usually performance or information, is better than it actually is. These phenomena are the subject of a large literature in psychology, economics, and finance, having been first documented in Alpert and Raiffa (1982). This literature has documented overconfidence in a wide range of contexts, and among people from a wide range of backgrounds.

Moore and Healy (2007, 2008) divide overconfidence into three, often conflated, categories: over-estimation, over-placement, and over-precision. Over-estimation is when people believe that their performance on a task is better than it actually is. Over-placement is when people incorrectly believe that they perform better than others, as in the classic statement, “93 percent of drivers believe that they are better than average.”<sup>4</sup>

In this paper we focus on over-precision: the belief that one’s information is more precise than it actually is. There are two reasons for this focus. First, while over-estimation and over-placement often suffer from reversals,<sup>5</sup> this does not seem to be the case for over-precision. In other words, it appears that (almost) everyone exhibits over-precision (almost) all the time (Moore and Healy 2007, 2008). Second, over-precision has a very natural interpretation in political contexts: it is the result of people believing that their own experiences are more informative about policy than they actually are. Despite our narrower focus, we continue to use the term overconfidence.

Overconfidence is usually a modeling fundamental. By contrast, as noted above, we derive it as a consequence of correlational neglect. This allows for the derivation of additional predictions on the evolution of overconfidence and extremism with age and media exposure.

### B. *Literature*

This work contributes to the emerging literature on behavioral political economy, which applies findings from behavioral economics to understand the causes and consequences of political behavior.<sup>6</sup> This approach promises to allow political economists to integrate the insights of a half-century of psychology-based political behavior studies.

A particular appeal of applying behavioral insights to political economy is that many of the feedback mechanisms that have led scholars to doubt the importance of behavioral phenomena in markets do not seem to exist in politics. Specifically, as an individual’s political choice is unlikely to be pivotal, citizens who make poor political choices do not suffer worse consequences than those who make good political choices. Moreover, this lack of direct feedback drastically reduces a citizen’s ability

<sup>4</sup>Interestingly, this may be perfectly rational (see Benoît and Dubra 2011).

<sup>5</sup>That is, people tend to under-estimate their performance when a task is easy, and over-estimate when the task is difficult (Erev, Wallsten, and Budescu 1994).

<sup>6</sup>This literature is small, and includes Matsusaka (1995); Bendor, Diermeier, and Ting (2003); Bendor et al. (2011); Callander and Wilson (2006, 2008); Bisin, Lizzeri, and Yariv (forthcoming); Degan and Merlo (2011); Lizzeri and Yariv (2012); and Passarelli and Tabellini (2013).

to learn of her bias. This is in stark contrast to markets, where poor choices directly impact the decision maker, which some scholars argue will eliminate behavioral biases. Furthermore, behavioral traits that may be detrimental in markets may, in some cases, be useful in facilitating collective action (Bénabou and Tirole 2002, 2006; Bénabou 2008).

Two papers focus on the normative implications of correlational neglect in political economy. Glaeser and Sunstein (2009) study “credulous Bayesian” information transmission in groups. This follows models in which correlational neglect is related to network structure (DeGroot 1974; DeMarzo, Vayanos, and Zwiebel 2003; Golub and Jackson 2010; Chandrasekhar, Larreguy, and Xandri 2012). It notes that this bias may lead to group polarization, overconfidence in beliefs, and worse aggregate decision making. Levy and Razin (forthcoming), in contrast, show that correlational neglect may lead to better information aggregation in elections. Our work has a different focus: we present a general model of correlational neglect, and derive and test positive results to understand the interrelationships between overconfidence, ideology, extremism, turnout, party identification, media exposure, and age.

This paper is related to a number of additional literatures. First and foremost, the study of ideology, voting, and partisan identification are the subject of a large literature in political science. Second, overconfidence is the focus of a large literature in behavioral economics and finance (see, for example, Odean 1998; Daniel, Hirshleifer, and Subrahmanyam 1998; Camerer and Lovallo 1999; Santos-Pinto and Sobel 2005). Third, there are a small number of papers that study the role of beliefs on preferences for redistribution (Piketty 1995; Alesina and Angeletos 2005). Fourth, our modeling technique comes from the small literature utilizing the normal learning model.<sup>7</sup> Finally, our model of turnout follows those in which voters are either regret- or choice-avoidant (Matsusaka 1995; Degan and Merlo 2011; Degan 2013).<sup>8</sup>

### *C. Structure*

This paper is unconventionally structured: it rotates between theoretical and empirical results. This allows for the data to inform the theoretical analysis, and clarifies the role that assumptions play in results. Section I introduces the theoretical structure and Section II gives an overview of our data. Our analysis begins in Section IIIA with an examination of how overconfidence and ideology evolve with the number of signals. This preliminary check shows that implications of our model that differ from a fully Bayesian benchmark find strong support in our data. Section IIIB examines our primary result: the correlation between overconfidence and ideological extremeness. In addition, the restrictions from the previous subsection allow for predictions about ideology and overconfidence. The final two subsections of Section III examine additional, more subtle, predictions about the relationships between overconfidence, ideology, and extremeness.

<sup>7</sup> Although the literature is not large, it cannot be completely reviewed here. Early papers include Zechman (1979) and Achen (1992). For a recent review, see the introduction of Bullock (2009). In this literature, our model is closest to Blomberg and Harrington (2000), although like all fully Bayesian models, this model is inconsistent with the data here, as discussed in Section IIIA.

<sup>8</sup> For a discussion of how our results relate to other models of voter turnout, see the online Appendix.

Section IV adds the expressive voting structure that allows our model to generate predictions for turnout and partisan identification. Section V examines theoretically how our results would change if citizens could acquire additional information. Finally, Section VI discusses issues related to identification, and directions for future work.

## I. Theoretical Framework

This section presents our model and formally defines correlational neglect and overconfidence. This is followed by a discussion of our data, and how we use it to construct measures of overconfidence, ideology, voter turnout, and partisan identification.

There is a unit measure of citizens  $i \in [0, 1]$ . Each citizen  $i$  has a utility over political actions that depends on a state of the world. A citizen's beliefs about the state are determined by her experiences, and ideology encompasses both beliefs about the state and preferences.

*Utilities.*—Each citizen  $i$  has a standard quadratic-loss utility over actions  $a_i \in \mathbb{R}$ , which depends on a state  $x \in \mathbb{R}$ , and a preference bias  $b_i$

$$U(a_i, b_i | x) = -(a_i - b_i - x)^2.$$

Throughout this paper,  $a_i$  is the policy implemented by the government. A citizen's preference bias is an i.i.d. draw from a normal distribution with mean 0 and precision  $\tau_b$ . We write this as  $b_i \sim \mathcal{N}[0, \tau_b]$ . The state  $x$  is a single draw from  $\mathcal{N}[0, \tau]$ .

With uncertainty about the state, it is straightforward to show that the policy preferred by citizen  $i$  will be  $a_i^* = b_i + E_i[x]$ , where  $E_i$  is the expectation taken over citizen  $i$ 's beliefs. We define this quantity as the citizen's *ideology*,

$$(1) \quad \mathcal{I}_i \equiv b_i + E_i[x],$$

and, as the expectation of  $x$  is zero, ideological extremeness as  $\mathcal{E}_i \equiv |\mathcal{I}_i|$ .

*Experiences, Beliefs, and Correlational Neglect.*—The core of the model is the process by which citizens form beliefs about the state. In our model, each citizen is well calibrated about the informativeness of individual experiences, but underestimates how correlated her experiences are. This will lead to varying degrees of overconfidence in the population.

Each citizen starts with the correct prior  $\mathcal{N}[0, \tau]$  about the state. Citizens have multiple experiences over time, which are signals about the state,  $e_{it} = x + \varepsilon_{it}$ ,  $t \in \{1, 2, \dots, n_i\}$ , with  $e_{it}$  independent of  $b_i$ , that is  $e_{it} \perp b_i$ . Each  $\varepsilon_{it} \sim \mathcal{N}[0, 1]$ , and the signals are correlated, with  $\text{corr}[\varepsilon_{it}, \varepsilon_{it'}] = \rho$ . However, citizen  $i$  underestimates this correlation: she believes  $\text{corr}[\varepsilon_{it}, \varepsilon_{it'}] = \rho_i \in [0, \rho]$ .<sup>9</sup>

<sup>9</sup>Formally,  $\varepsilon_i$  is distributed according to a mean-zero multinomial normal with covariance matrix

$$\Sigma_{\varepsilon_i} = \begin{pmatrix} 1 & \rho & \cdots & \rho \\ \rho & 1 & \cdots & \rho \\ \vdots & \vdots & \ddots & \vdots \\ \rho & \rho & \cdots & 1 \end{pmatrix}. \text{ However, citizen } i \text{ believes that } \Sigma_{\varepsilon_i} = \begin{pmatrix} 1 & \rho_i & \cdots & \rho_i \\ \rho_i & 1 & \cdots & \rho_i \\ \vdots & \vdots & \ddots & \vdots \\ \rho_i & \rho_i & \cdots & 1 \end{pmatrix}.$$

Each  $\varepsilon_{it}$  has unit variance, so  $\text{corr}[\varepsilon_{it}, \varepsilon_{it'}] = \text{cov}[\varepsilon_{it}, \varepsilon_{it'}] = \rho$ .



DEFINITION 1: A citizen suffers from correlational neglect when  $\rho_i < \rho$ .

The magnitude of correlational neglect varies by citizen, and is an i.i.d. draw from  $F_{\rho_i}$  with support  $[0, \rho)$ , and  $\rho_i \perp (e_{it}, b_i)$ . As  $\rho_i < \rho$  for all  $i$ , all citizens in our model are correlational neglecters.

For tractability, we assume  $n_i$ , the number of signals received by citizen  $i$ , is exogenous. Section VA relaxes this assumption, and shows that more overconfident citizens value additional information more highly, and thus endogenizing the acquisition of information strengthens our results.

*Overconfidence.*—As our data measures overconfidence, our theoretical results are in terms of this variable. Denote the precision of citizen  $i$ 's posterior belief as  $\kappa_i + \tau$ , which we refer to as the citizen's *confidence*. Additionally, denote by  $\kappa + \tau$  the posterior belief the citizen would have if she had accurate beliefs about the correlation between signals.

DEFINITION 2: Overconfidence is the difference between a citizen's confidence and how confident she would be if she were properly calibrated,  $\kappa_i - \kappa$ . Given two citizens  $i$  and  $j$ , we say that  $i$  is more overconfident than  $j$  if  $\kappa_i \geq \kappa_j > 0$ .<sup>10</sup>

We often refer to  $\kappa_i$  as a citizen's level of overconfidence.

Before discussing data, we briefly comment on the interpretation of  $x$ . Research that uses a similar utility function sees this state variable as informative of optimal policy. However, this may lead to unappealing normative implications. In particular, it suggests that the optimal policy could be found by studying the distribution of public opinion, and that this policy may be more extreme than the median of fairly extreme groups. To keep the same structure, but eliminate such conclusions, we could simply add an aggregate bias to the signaling structure.<sup>11</sup> As this additional uncertainty affects every citizen in the same way, it does not affect most of our conclusions. However, it would affect how citizens learn from each other, a subject we examine in Section VB.

## II. Data

Our data comes from the Harvard and Caltech modules of the 2010 Cooperative Congressional Election Study (CCES) (Alvarez 2010; Ansolabehere 2010a, b). This data is unique (as far as we know) in that it allows a survey-based measure of overconfidence in beliefs as well as political characteristics.

The CCES is an annual cooperative survey. Participating institutions purchase a module of at least 1,000 respondents, who are asked 10–15 minutes of customized questions. In addition, every respondent across all modules is asked the same battery of basic economic and political questions. The complete survey is administered

Alternatively, we could model the state in a multidimensional space with multidimensional errors over time, and citizens either underestimate the amount of correlation between dimensions, or across time, or both. This does not add to the testable predictions of the model (see the online Appendix).

<sup>10</sup> All results hold defining overconfidence as  $\kappa_i/\kappa$ .

<sup>11</sup> This would be expressed formally as:  $\varepsilon_{it} \sim \mathcal{N}[\pi_0, 1]$  with  $\pi_0 \sim \mathcal{N}[0, 1]$  identical for all citizens.

online by Knowledge Networks. Each module uses a matched-random sampling technique to achieve a representative sample, with oversampling of certain groups (Ansolabehere 2012; Ansolabehere and Rivers 2013).

### A. *Overconfidence*

The most important feature of this data, for our purposes, is that it allows for a measure of overconfidence. This measure is constructed from four subjective questions about respondent confidence in their guesses about four factual quantities, adjusting for a respondent's accuracy on the factual question. This is similar to the standard psychology measure in that it elicits confidence and controls for knowledge. However, it differs in that we cannot say for certain whether a given respondent is overconfident, just that their confidence, conditional on knowledge, is higher or lower than another respondent. Therefore, we use previous research, which shows that (almost) everyone exhibits over-precision (almost) all the time (Moore and Healy 2007, 2008) to argue that this is a measure of overconfidence.<sup>12</sup>

The factual and confidence questions were asked as part of another set of studies (Ansolabehere, Meredith, and Snowberg 2013, 2014). Respondents were asked their assessment of the current unemployment and inflation rate, and what the unemployment and inflation rate would be a year from the date of the survey. Respondents were then asked their confidence about their answer to each factual question on a qualitative, six-point scale.

Confidence reflects both knowledge and overconfidence, so subtracting knowledge from confidence leaves overconfidence.<sup>13</sup> To subtract knowledge, we deduct points from a respondent's reported confidence based on his or her accuracy, and thus knowledge, on the corresponding factual question. This is implemented conservatively: we regress confidence on an arbitrary, fourth-order polynomial of accuracy, and use the residual as a measure of overconfidence.<sup>14</sup> This allows the regression to pick the points to deduct for each level of accuracy, such that knowledge absorbs as much variation as possible.

Each of the resultant overconfidence measures are measured with error, as some respondents with little knowledge will randomly provide accurate answers. Thus, we use the first principal component of the four measures.<sup>15</sup> Finally, to standardize regression coefficients, we subtract the minimum level of overconfidence, and divide by the standard deviation.

<sup>12</sup>Psychological studies typically elicit a large (up to 150) number of 80 percent confidence intervals and count the percent of times that the actual answer falls within a subject's confidence interval. This number, subtracted from 80, is used as a measure of overconfidence. Our measure has advantages over the typical psychology approach: see the online Appendix, which also contains all survey questions.

<sup>13</sup>Theoretically, we need to control for the precision a citizen would have if they were properly calibrated. As we do not observe this, we control for accuracy, which is, in our theory, correlated.

<sup>14</sup>That is, we use a semi-nonparametric sieve method to control for knowledge (Chen 2007). Ideally one would impose a monotonic control function; however, doing so is methodologically opaque (see Athey and Haile 2007; Henderson et al. 2009). In keeping with the treatment of these factual questions in Ansolabehere, Meredith, and Snowberg (2013, 2014), we topcode responses to the unemployment and inflation questions at 25, limiting a respondent's inaccuracy.

<sup>15</sup>Consistent with each measure consisting of an underlying dimension plus i.i.d. measurement error, the first principal component weights each of the four questions approximately equally. Also consistent with this structure, our results are substantively similar using any one of the four questions in isolation. So, for example, they hold if we use only variables pertaining to present conditions, or only to future predictions.



TABLE 1—OVERCONFIDENCE IS CORRELATED WITH GENDER AND AGE,  
BUT NOT EDUCATION OR INCOME

	Overconfidence			Confidence		
Gender (male)	0.45*** (0.079)	0.44*** (0.080)	0.43*** (0.079)	0.48*** (0.077)	0.47*** (0.078)	0.46*** (0.077)
Age (in years)	0.012*** (0.0023)	0.013*** (0.0024)	0.012*** (0.0023)	0.013*** (0.0022)	0.014*** (0.0023)	0.013*** (0.0022)
Education	$F = 1.11$ $p = 0.36$			$F = 2.03$ $p = 0.08$		
Income	$F = 1.34$ $p = 0.20$			$F = 1.82$ $p = 0.05$		
Observations	2,927					

Notes: Standard errors, clustered by age (73 clusters), in parentheses. All specifications estimated using WLS with CCES sampling weights.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

In keeping with previous research, overconfidence is strongly correlated with a respondent's gender, as shown in Table 1 (see, for example, Lundeberg, Fox, and Punčohaf 1994). Section IIIA predicts that overconfidence is correlated with age. This is also clear in Table 1. This predicted relationship leads us to cluster standard errors by age.<sup>16</sup> Additionally, as the CCES oversamples certain groups, such as voters, we estimate specifications using weighted least squares (WLS) and the supplied sample weights (Ansolabehere 2012).

However, overconfidence is uncorrelated with education or income. Note that these latter controls are ordered categorical variables, so we provide  $F$ -tests on the 5 and 15 dummy variables that, respectively, represent these categories. For comparison, we construct a confidence measure from the first principal component of confidence scores. Education and income are related to this measure, providing some confirmation that actual knowledge has been purged from the overconfidence measure.<sup>17</sup>

While the data we use to elicit overconfidence is quite similar to that used in psychology, there are some differences. First, we use questions about economic measures—unemployment, inflation—as opposed to general knowledge questions: for example, “When was Shakespeare born?” Second, these questions elicit confidence directly, while studies in psychology typically elicit confidence intervals. To understand whether our slightly different approach provides similar results, we added four general knowledge questions—eliciting confidence with an interval—to the 2011 CCES. The 2011 CCES also included the confidence questions from the 2010 version. The main finding is reassuring: the results we can examine in the (more limited) 2011 CCES hold using general knowledge-based measures of overconfidence. These results can be found in Section VIA, and more about using surveys to measure overconfidence can be found in the online Appendix.

<sup>16</sup> Age also has a greater intraclass correlation than state of residence, education, or income, making age the most conservative choice. The intraclass correlation is small for all of these variables, thus clustering on any one of them produces similar results, which are also similar to heteroskedastic-consistent standard errors. For consistency, we continue to cluster by age when age is on the right-hand side. Classical standard errors are approximately 25 percent smaller.

<sup>17</sup> All our results—theoretical and empirical—hold using confidence rather than overconfidence.

### B. *Dependent Variables*

The predictions in this paper concern three types of dependent variables: ideology, voter turnout, and strength of partisan identification.

*Ideology.*—This study uses one main and two alternative measures of ideology. The main measure is scaled ideology from Tausanovitch and Warshaw (2011), which they generously provided to us. This measure is generated using item response theory (IRT) to scale responses to 18 issue questions asked on the CCES—for example, questions about abortion and gun control. A similar process generates the Nominate Scores used to evaluate the ideology of members of Congress (Poole and Rosenthal 1985).<sup>18</sup>

Our alternative measures of ideology are direct self-reports. The CCES twice asks respondents to report their ideology: from extremely liberal to extremely conservative. The first elicitation is when the respondent agrees to participate in surveys (on a five-point scale), and the second when taking the survey (on a seven-point scale). We normalize each of these measures to the interval  $[-1, 1]$ , and average them. Those who report they “don’t know” are either dropped from the sample or treated as moderates (0). Results are presented for both cases. These self-reported measures are imperfectly correlated with scaled ideology (0.42).<sup>19</sup>

*Voter Turnout.*—Turnout is ascertained from the voting rolls of the state in which a respondent lives. Voter rolls vary in quality between states, but rather than trying to control for this directly, we include state fixed effects in most of our specifications.<sup>20</sup>

*Partisan Identification.*—At the time of the survey, respondents were asked whether they identify with the Republican or Democratic Party, or neither. If they report one of the political parties—for example the Democrats—they are then asked if they are a “Strong Democrat” or “Not so Strong Democrat.” Those who report they were neither Republican nor Democrat were asked if they lean to one party or the other, and are allowed to say that they do not lean toward either party. Those who report they are strong Democrats or Republicans are coded as strong partisan identifiers. Independents—those who do not lean toward either party—are coded as either strong party identifiers, weak party identifiers, or are left out of the analysis. Results are presented for all three resultant measures.

<sup>18</sup>There are many ways to aggregate these individual issues into ideology. For example, one could aggregate groups of related issues into different ideological dimensions. To eliminate concerns about specification searching, we prefer to use a measure generated by other scholars (see the online Appendix).

<sup>19</sup>In improving and refining the paper in accordance with referee suggestions, we eliminated a number of specifications found in the working paper (Ortoleva and Snowberg 2013). This working paper includes more specifications with alternative ideology measures, extremism measures that are constructed directly from ideology without first controlling for economic variables, demographic controls, and unweighted specifications. The results in all cases are similar.

<sup>20</sup>The state of Virginia did not make their rolls available, so the 60 respondents from Virginia are dropped from turnout regressions (see Ansolabehere and Hersh 2010). Classifying as nonvoters the 42 respondents who were found to have voted in the primary but not the general election does not significantly alter the results.

### C. Controls

*Economic Controls.*—Political economy theories generally view ideology as a function of wealth or income. Therefore, we include controls for all the wealth- and income-related variables in the CCES. The CCES provides these controls as categories: for example, rather than providing years of education, it groups education into categories such as “Finished High School.” Thus, we introduce a dummy variable for each category of each economic control. We also include a category for missing data for each variable. These controls are: income (16 categories), education (6 categories), stock ownership (3 categories), home ownership (4 categories), union/union member in household (8 categories), state (52 categories, including DC and missing).

*Number of Signals.*—The CCES contains two sets of questions that are reasonable proxies for the number of signals: media exposure and age. The CCES contains four questions that ask whether or not a respondent received news from a specific media channel: blogs, TV, radio, and newspapers. We take the first principal component of these four yes/no questions to create a more continuous index of media exposure. This principal component also deemphasizes TV, as nearly all respondents report getting political information from this channel. Age is calculated as 2010—the year of the survey—minus birth year.

All controls are entered categorically. This strategy is both too conservative and not conservative enough. Not conservative enough because there are likely other relevant unobserved factors, and too conservative, as entering these variables categorically allows the implied control function to be nonmonotonic, as opposed to the theoretical monotonic relationship. There are 16 categories of media exposure, and 73 categories (years) for age.

## III. Ideology, Extremeness, and Overconfidence

We begin our analysis by contrasting our model with fully Bayesian models, and then continue to our primary results.

### A. Media, Age, Overconfidence, and Ideology

Our model is partially Bayesian—citizens update using Bayes’ rule, but with an incorrect likelihood function. Obvious alternative models are *fully Bayesian*, in which citizens are correct about the link between their experiences and the state  $x$ , and citizens eventually learn  $x$ . In this subsection we show that such alternative models are incompatible with an important feature of the data: ideological extremeness increases with the number of experiences (signals).

In particular, consider any fully Bayesian model in which citizens’ priors have full support, and they receive  $n$  private signals. Then there exists some  $n^*$  such that if  $n > n^*$  the variance of citizens’ posterior means is non-increasing in  $n$ . Note the fact that citizens’ posterior means may initially diverge is due to the fact that if citizens have a common prior mean, the first signal(s) will cause divergence. After these initial signals, the variance of posterior means must weakly decrease as more

information is revealed and citizens learn  $x$ . Of course, if all citizens' prior means are  $x$ , then posteriors need never diverge or converge.

This implies that the population variance of ideology, conditional on  $n$ ,  $\text{var}[\mathcal{I}_i | n]$  is non-increasing in  $n$  in fully Bayesian models. In contrast, in our model:

**PROPOSITION 1:**

- (i) *Overconfidence is increasing with the number of experiences (signals)  $n$ .*
- (ii) *The mean ideology in the population, conditional on  $n$ ,  $E[\mathcal{I}_i | n]$ , is increasing in  $n$  if and only if  $x > 0$ , and decreasing in  $n$  if and only if  $x < 0$ .*
- (iii) *If  $\rho$  is large enough,  $\text{var}[\mathcal{I}_i | n]$  is increasing in  $n$ .*

**PROOF:**

All proofs can be found in the online Appendix.

To build intuition for Proposition 1, consider the extreme case in which  $\rho_i = 0$  and  $\rho = 1$ : that is, when experiences are perfectly correlated, but citizen  $i$  believes that they are independent. In this case, each experience is identical, so it will make the citizen more confident without increasing her information—leading to the first part of the proposition. Moreover, as the mean of the ideology distribution will tend toward  $x$  as  $n$  increases, if  $x > 0$ , then ideology will increase with  $n$ .

The final part of Proposition 1 implies that under certain parameter values our model is compatible with patterns that are incompatible with fully Bayesian models: citizens' beliefs could become more polarized with more signals. To understand the difference, note that when  $\rho$  is large in our model, then each additional signal contains very little new information, yet some citizens believe it does. New signals will thus push their beliefs toward a biased view of  $x$ , rendering subjects more polarized. As described above, this would not be the case in a fully Bayesian model, as citizens beliefs will converge toward  $x$ —or, at least, not diverge.

Before turning to the empirical examination of this proposition, we note that this proposition provides a potential answer to the first puzzle posed in the introduction: why politicians and voters are becoming more polarized, despite the increased availability of information through the Internet (McCarty, Poole, and Rosenthal 2006). The third part of the proposition suggests that an increase in the number of signals can actually increase ideological extremeness, and thus, polarization. This occurs because additional signals are correlated, and thus provide limited additional information. Citizens neglect this correlation, and thus update *too much*, which increases polarization. Note that this occurs even if media exposure is not more polarized, as seems to be the case (Gentzkow and Shapiro 2011).

*Empirical Analysis.*—We examine the patterns suggested by Proposition 1, using media exposure as a measure of  $n$ , in Figure 1. The visual patterns in Figure 1 are found to be statistically robust in Table 2. Each panel of Figure 1 shows a smoothed, nonparametric fit with 95 percent confidence intervals, and averages for each value of the media index. The first panel shows that, in accordance with Proposition 1,

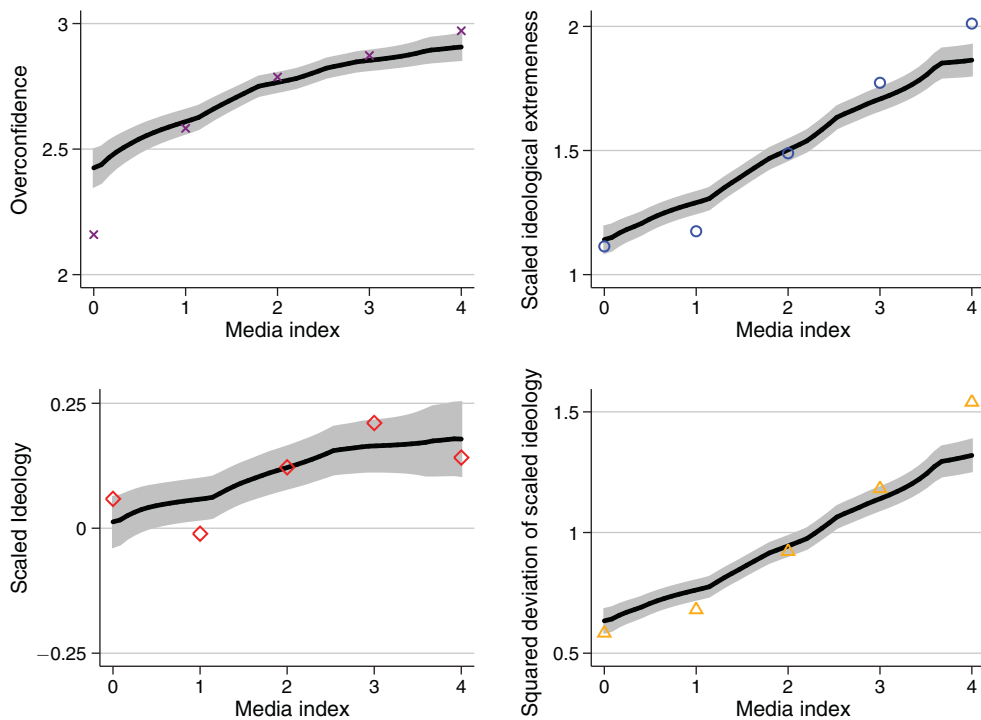


FIGURE 1. MEDIA EXPOSURE, OVERCONFIDENCE, AND IDEOLOGY

*Notes:* Each point is the average for those respondents with a specific index of media exposure intensity (that is, blogs, tv, radio, and newspaper) rounded to the nearest integer. Trendiness, in black, and 95 percent confidence intervals, in gray, use an Epanechnikov kernel with a bandwidth of 0.8.

TABLE 2—REGRESSIONS SUPPORT THE VISUAL PATTERNS IN FIGURE 1

	Overconfidence		Ideology		Squared deviation	
Media index	0.21*** (0.041)	0.15*** (0.038)	0.059** (0.023)	0.055** (0.022)	0.29*** (0.028)	0.19*** (0.028)
Economic controls		Yes		Yes		Yes
Age (73 categories)		Yes		Yes		Yes
$R^2$	0.042	0.23	0.035	0.17	0.085	0.26
Age	0.20*** (0.037)	0.15*** (0.038)	0.12*** (0.030)	0.066** (0.030)	0.16*** (0.030)	0.14*** (0.033)
Economic controls		Yes		Yes		Yes
Media (16 categories)		Yes		Yes		Yes
$R^2$	0.040	0.19	0.014	0.16	0.027	0.24
Observations	2,927		2,868		2,868	

*Notes:* Standard errors, clustered by age (73 clusters), in parentheses. All specifications estimated using WLS with CCES sampling weights. Coefficients on age are standardized.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

overconfidence increases with media exposure. The second panel shows that ideological extremeness increases with media exposure. The third and fourth panels show that this is due to both a rightward shift associated with more media exposure,

and an increase in ideological dispersion. This, along with the second and third parts of Proposition 1, implies certain restrictions on the parameters of the model. In particular:

IMPLICATION 1:  $x > 0$ .<sup>21</sup>

IMPLICATION 2:  $\rho$  is large enough so that  $\text{var}[\mathcal{I}_i | n]$  is increasing in  $n$ .

The second implication can be examined in other datasets: Ortoleva and Snowberg (forthcoming) replicates the fourth panel of Figure 1 over several decades using data from the American National Election Survey.

While the fourth panel of Figure 1 shows that the data is inconsistent with any fully Bayesian model, neither it nor the third panel is a test of our model. Specifically, the second and third part of Proposition 1 allows for either an increasing or decreasing relationship, depending on parameter values. Moreover, in proving this result we have assumed that media exposure is exogenous, which is unlikely to hold. We address this issue in two ways. First, we show theoretically in Section VA that endogenizing media exposure strengthens our results. Intuitively, this occurs because more overconfident citizens neglect correlation to a greater degree, and thus believe that additional signals are more valuable. They will thus consume more media, becoming more overconfident, and more extreme.

Second, we also examine our results using another proxy for the number of signals: age. Age is not a choice, nor is it likely to be affected by one's overconfidence or ideology. Moreover, as we have already made parametric restrictions on the basis of Figure 1, Proposition 1 now gives testable predictions for the relationships between age, overconfidence, ideology, and extremeness. In particular, the patterns with respect to age should be the same as those with respect to media. These predictions are tested, and shown to hold, in Table 2. Moreover, the regressions show that the patterns with respect to age are robust to controlling for media, and vice versa.

To summarize, the patterns in the data are inconsistent with any fully Bayesian model, but are consistent with our theory. Moreover, to draw additional, testable predictions, we use the implications of these patterns as assumptions in some of what follows. When doing so, we state it explicitly.

### B. Ideological Extremeness

Our primary result is:

PROPOSITION 2: *Overconfidence and ideological extremeness are positively correlated. This is true conditional on  $n$ , and independent of  $n$  if  $\rho$  is large enough.*<sup>22</sup>

<sup>21</sup>Note that this does not imply that conservative citizens are "correct" (see the end of Section I).

<sup>22</sup>Specifically, this holds as long as  $\rho$  is large enough that the population variance of ideology, conditional on  $n$ ,  $\text{var}[\mathcal{I}_i | n]$ , is increasing in  $n$  (see Proposition 1).



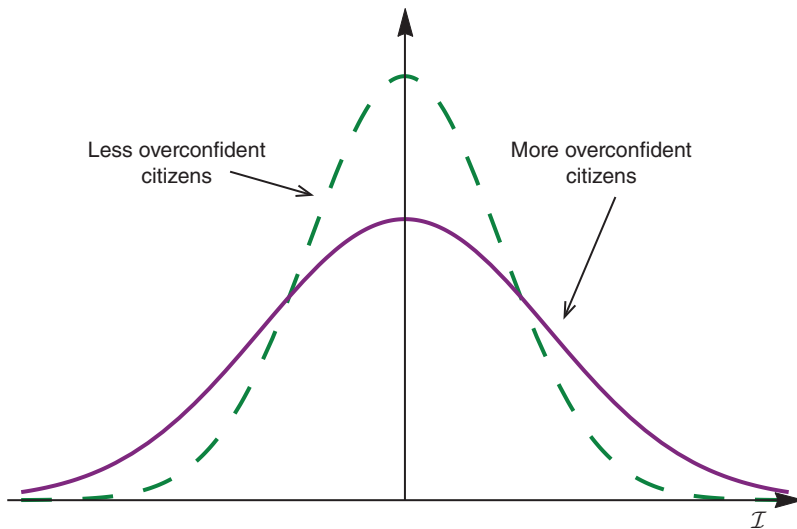


FIGURE 2. OVERCONFIDENCE AND IDEOLOGICAL EXTREMENESS ARE CORRELATED

To build the intuition of this result, it is useful to recast our model as one in which citizens receive only a single signal, but overestimate its precision. Specifically, we can model each citizen as if they have a single experience  $e_i = x + \varepsilon_i$ , where  $\varepsilon_i \sim \mathcal{N}[0, \kappa]$ ,  $\forall i$ . However, citizens overestimate the precision of this signal: that is, they believe that  $\varepsilon_i \sim \mathcal{N}[0, \kappa_i]$ , where  $\kappa_i \geq \kappa$ . If we properly define  $e_i$ ,  $\kappa$ , and  $\kappa_i$ , then this model will give the same results when there is no heterogeneity in  $n$ .

LEMMA 1: Define  $e_i \equiv \frac{1}{n_i} \sum_{t=1}^{n_i} e_{it}$ . Then  $\kappa = \frac{n_i}{1 + (n_i - 1)\rho}$ , and  $\kappa_i = \frac{n_i}{1 + (n_i - 1)\rho_i}$ .

Fix  $n$  and consider two citizens with the same preference bias  $b = 0$  and the same experience  $e \geq 0$ , but two different levels of overconfidence  $\kappa_1$  and  $\kappa_2$ , with  $\kappa_1 > \kappa_2$ . Using the definition of ideology in (1) and Bayes' rule:  $\mathcal{I}_i = b_i + E_i[x] = \frac{\kappa_i e}{\tau + \kappa_i}$ , where  $E_i$  is the expectation over citizen  $i$ 's beliefs. As citizens' mean beliefs, and hence ideology, are increasing in  $\kappa_i$ , then the more overconfident citizen will have a more extreme ideology. Intuitively, the more overconfident citizen believes her experience is a better signal of the state, and hence updates more, becoming more extreme.

To see that this results in a positive correlation, we examine the entire distribution of ideologies. The logic above implies that the distribution of ideologies for those who are more overconfident will be more spread out than the distribution for those who are less overconfident. Figure 2 shows the distribution of ideologies for two levels of overconfidence with  $x = 0$ . In that figure, as one moves further from the ideological center, citizens are more likely to be more overconfident, generating a positive correlation between overconfidence and ideological extremeness. The simplicity of the figure is driven by the assumption that  $x = 0$ : if  $x \neq 0$ , the distributions will not be neatly stacked on top of each other, and the relationship will be more complex—but Proposition 2 shows that there is a positive correlation

TABLE 3—OVERCONFIDENCE IS ROBUSTLY RELATED TO IDEOLOGY AND EXTREMENESS

	Ideology			Ideological extremeness purged of economic controls		
Overconfidence	0.22*** (0.027)	0.22*** (0.023)	0.20*** (0.023)	0.23*** (0.028)	0.17*** (0.027)	0.12*** (0.026)
Economic controls		Yes	Yes		Yes	Yes
Number of signals			Yes			Yes
$R^2$	0.048	0.16	0.23	0.055	0.19	0.29
Observations	2,868					

Notes: Standard errors, clustered by age (73 clusters), in parentheses. All specifications estimated using WLS with CCES sampling weights.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

between overconfidence and ideological extremeness for any value of  $x$ .<sup>23</sup> Using Implication 1 we can also derive an additional prediction:

**PROPOSITION 3:** *If  $x > 0$  overconfidence and ideology are positively correlated, both independent of, and conditional on,  $n$ .*

Proposition 3 follows directly from the discussion above. As the full distribution of  $e_i$  is unbiased,  $E[\mathcal{I}_i | \kappa_i] = \frac{\kappa_i x}{1 + \kappa_i}$ . When  $x > 0$ , this is increasing in  $\kappa_i$ .

*Empirical Analysis.*—As political economy theories generally view ideology as a function of wealth or income, we first control for the effect of economic variables—as listed in Section IIC—on ideology. We then take the absolute value of the residuals from these regressions as measures of ideological extremeness. All three measures of ideology and ideological extremeness are divided by their standard error to standardize regression coefficients. The first three columns of Table 3 show both an empirical examination of Proposition 3, and the regression, in the second column, used to construct the ideological extremeness measure.

We now examine our primary prediction—Proposition 2—by regressing the resultant measure of ideological extremeness on overconfidence. The relationship between ideological extremeness and overconfidence is statistically very robust—with  $t$ -statistics on this novel result between  $\sim 5$  and  $\sim 10$ .<sup>24</sup>

While we have shown that the relationship between ideological extremeness or ideology and overconfidence is statistically robust, is it substantively important? Table 4 suggests the answer is yes. Specifically, it shows the change in ideological extremeness, and ideology, associated with a one standard deviation change in the various economic controls. As the table shows, overconfidence is as predictive

<sup>23</sup>The proof of Proposition 2 relies on the fact that both overconfidence and extremeness are increasing in correlational neglect. Any distribution of noise that has this property will produce the same results. For more discussion, see the online Appendix.

<sup>24</sup>The closest empirical result we are aware of appears in footnote 14 of Kuklinski et al. (2000), which notes a strong correlation (0.34) between strength of partisan identification and confidence in incorrect opinions.

TABLE 4—OVERCONFIDENCE IS A SUBSTANTIVELY IMPORTANT PREDICTOR OF IDEOLOGY AND IDEOLOGICAL EXTREMENESS

A one standard deviation change in _____ is associated with	A ____ standard deviation change in ideology, and		A ____ standard deviation change in extremeness	
	Minimum	Maximum	Minimum	Maximum
Income	0.06	0.08	0.01	0.28
Education	0.10	0.20	< 0.01	0.25
Union member	0.01	0.07	< 0.01	0.08
Home owner	0.02	0.17	< 0.01	0.15
Stock owner	0.06	0.14	< 0.01	0.27
Overconfidence	0.17	0.24	0.12	0.26

*Notes:* The minimum and maximum effect size come from regressions with no other variables, and all other variables, respectively, across the three different measures of ideology and extremeness. These specifications can be found in the online Appendix. For the controls, we consider extremeness measures both that have, and have not, been purged of the economic effect on ideology. Effect sizes for categorical variables are based on entering them linearly in regressions.

of ideological extremeness as income, education, and stock ownership, and more predictive than union membership, home ownership, or age. Moreover, as this relationship is more consistent across specifications, it suggests that overconfidence is a separate phenomenon that is not captured by standard controls. A similar pattern emerges for left-right ideology. It is worth noting that income and education are fairly stable predictors of left-right ideology, although they are not as substantively important as overconfidence.

### C. Differences between Left and Right

We now use Implication 1 ( $x > 0$ ) to draw additional, subtle, predictions from the model.

**PROPOSITION 4:** *If  $x > 0$  then  $\text{cov}[\mathcal{E}, \kappa_i | \mathcal{I}_i \geq 0] > \text{cov}[\mathcal{E}, \kappa_i | \mathcal{I}_i \leq 0]$  both independent of, and conditional on,  $n$ .*

**PROPOSITION 5:** *If  $x > 0$  and  $\rho$  is large enough then  $\text{cov}[\mathcal{E}, n_i | \mathcal{I}_i \geq 0] > \text{cov}[\mathcal{E}, n_i | \mathcal{I}_i \leq 0]$ .<sup>25</sup>*

Proposition 4 states that if  $x > 0$ , then the covariance between overconfidence and extremeness is larger for those to the right-of-center than for those to the left-of-center. The mathematical intuition is illustrated in the left panel of Figure 3, which uses three different levels of  $\kappa_i$ . Moving right from the center, average overconfidence is quickly increasing, along with ideological extremeness. This leads to a large covariance between overconfidence and ideological extremeness. Moving left, ideological extremeness is also increasing, but average overconfidence initially decreases. Eventually, average overconfidence will increase, but this occurs in a region that contains a relatively small measure of citizens. Thus, the covariance to the left will be either small and negative or small and positive, depending on the

<sup>25</sup> Simulations indicate this holds for all  $\rho > \rho_i$ .  $\rho$  close to one is needed for tractability.

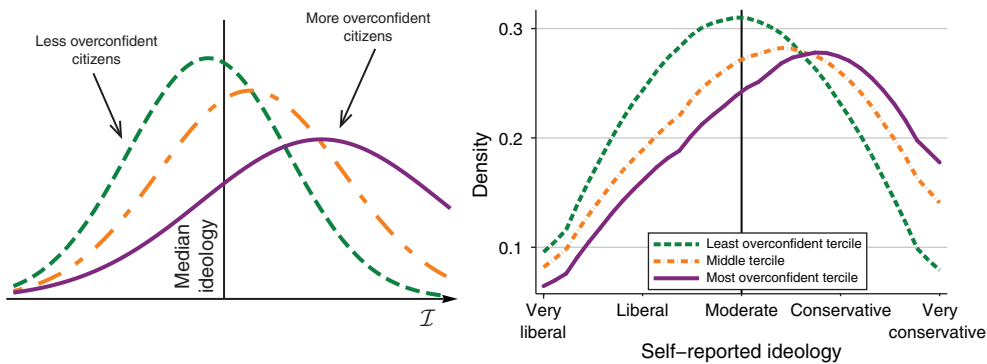


FIGURE 3. THE THEORETICAL STRUCTURE OF PROPOSITION 4, AND THE DATA USED TO EXAMINE IT

Notes: In the first panel, distribution of ideologies for three levels of overconfidence when  $x > 0$ . In the second panel, distribution of self-reported ideology by tercile of overconfidence. (Smoothed using an Epanechnikov kernel, bandwidth 0.8.)

relative measure of citizens in the regions with positive and negative covariances. Either way, the covariance between overconfidence and ideological extremeness will be smaller for left-of-center citizens than right-of-center citizens.

A similar logic underlies Proposition 5: fixing  $\rho_i$ , then by Proposition 1 overconfidence is increasing in  $n$ . Moreover, mean ideology increases in  $n$ —if Implication 1 holds—as does the variance of ideology—if Implication 2 holds—producing similar patterns to the left panel of Figure 3.

*Empirical Analysis.*—Initial support for the first part of Proposition 4 comes from a comparison of the left panel of Figure 3, generated by theory, and the right panel of Figure 3, generated from the data. A statistical analysis is found in the first panel of Table 5, which finds that ideological extremeness has a substantially higher covariance with overconfidence for those to the right of center than for those to the left of center, in accordance with Proposition 4. Proposition 5 also finds support in the statistical examination of Table 5. The final two columns control for age when testing the proposition using media, and control for media when testing the proposition using age. This emphasizes that although patterns in ideology with respect to media exposure and age may look similar, they are driven by distinct underlying variation.

It should be noted that while specular results hold if  $x < 0$ , these examinations are still tests of our model. In particular, the pattern in the left panel of Figure 3 is by Implication 1 ( $x > 0$ ), derived from the fact that ideology is increasing with media exposure. Indeed, it may be surprising that the data matches the implication of the theory as closely as it does in Figure 3. Propositions 4 and 5 provide a way to state, and test, this relationship statistically.

These patterns emphasize that our results are not driven by the relationship between overconfidence and ideology. Specifically, if overconfidence leads directly to conservatism, there should be a negative relationship between extremism and overconfidence for those left of center.<sup>26</sup> No such pattern exists in Table 5. Moreover,

<sup>26</sup>Formally, this would be modeled as  $\mathcal{I}_i = g(\kappa_i)$  with  $g' > 0$ .

TABLE 5—THERE IS A GREATER COVARIANCE BETWEEN EXTREMENESS AND OVERCONFIDENCE FOR RIGHT-OF-CENTER CITIZENS THAN LEFT-OF-CENTER CITIZENS

	Scaled extremeness (from ideology, purged of economic controls)					
	Left of center	Right of center	Left of center	Right of center	Left of center	Right of center
Covariance with overconfidence	0.063** (0.031)	0.28*** (0.037)	0.012 (0.027)	0.18*** (0.031)	−0.014 (0.024)	0.11*** (0.024)
Difference		0.22*** (0.049)		0.17*** (0.041)		0.13*** (0.034)
Economic controls			Yes	Yes	Yes	Yes
Number of signals					Yes	Yes
Covariance with media exposure	0.19*** (0.031)	0.33*** (0.040)	0.096*** (0.023)	0.20*** (0.037)	0.085*** (0.020)	0.16*** (0.035)
Difference		0.14*** (0.051)		0.10*** (0.044)		0.076** (0.040)
Economic controls			Yes	Yes	Yes	Yes
Age (73 categories)					Yes	Yes
Covariance with age	0.10*** (0.030)	0.21*** (0.049)	0.065*** (0.024)	0.16*** (0.037)	0.067*** (0.022)	0.14*** (0.036)
Difference		0.11** (0.057)		0.098** (0.044)		0.075** (0.042)
Economic controls			Yes	Yes	Yes	Yes
Media (16 categories)					Yes	Yes
Observations	1,123	1,745	1,123	1,745	1,123	1,745

Notes: One-tailed test used for differences, with standard errors, clustered by age (73 clusters), in parentheses. The Frisch-Waugh-Lovell Theorem is used to compute conditional covariances. Age is standardized in these regressions. Similar results hold using partial correlations.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

given the relationship between overconfidence and the number of signals in Table 2 (that is,  $d\kappa_i/dn_i > 0$ ), there should be a negative relationship between extremism and the number of signals for those left of center. This, too, does not find support. This implies that the mechanism we have identified applies to both liberals and conservatives. This point is discussed further in Ortoleva and Snowberg (forthcoming).

#### D. Covariances and the Number of Signals

Previous subsections have examined various elements of our theory: signals (age and media), correlational neglect (overconfidence), and ideological extremeness in a pairwise fashion. Our final proposition brings these elements together.

**PROPOSITION 6:** *If  $\rho$  is large enough, then  $\text{cov}[\mathcal{E}, \kappa_i - \kappa | n_i]$  is increasing in  $n_i$ .*

This proposition holds because the proportion of extremism and overconfidence that is due to signals—as opposed to priors or preference biases—is increasing in  $n_i$ . Importantly, as examining this proposition relies on grouping together citizens who

TABLE 6—THE COVARIANCE BETWEEN OVERCONFIDENCE AND IDEOLOGICAL EXTREMENESS ARE INCREASING IN  $n$ 

Quartile of media exposure:	Lowest	2nd lowest	2nd highest	Highest
cov $[\mathcal{E}, \kappa_i - \kappa   n]$	0.13** (0.063)	0.19*** (0.045)	0.19*** (0.038)	0.27*** (0.045)
Inter-quartile difference	0.058 (0.074)		0.0035 (0.059)	0.079* (0.059)
Two quartile difference		0.061 (0.077)	0.083* (0.059)	
Three quartile difference			0.14** (0.078)	
Observations	512	719	1,169	468

Notes: One-tailed test used for differences, with standard errors, clustered by age (73 clusters), in parentheses. All specifications estimated using WLS with CCES sampling weights. Unequal quartile sizes come from the use of sampling weights and the lumpiness of the media exposure measure.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

all have the same level of media exposure, whatever causes that particular level of exposure is held constant.<sup>27</sup>

*Empirical Analysis.*—We begin by breaking our sample into quartiles by level of media exposure, and then calculating the covariance between ideological extremeness and overconfidence for each quartile. The patterns in Table 6 are broadly supportive of Proposition 6. However, testing the proposition pushes the limits of our data—most differences are not statistically significant. Indeed, as the standard errors on the differences between quartiles are approximately 0.06, this means that differences of covariances must be about 0.1 to obtain statistical significance. This is close to the maximum difference in covariances between subgroups.

Including controls gives a difference between the first and fourth quartile of 0.12 (s.e. = 0.064,  $p < 0.05$ ). Dividing the sample quartiles in age produces a difference of 0.13 (s.e. = 0.095,  $p < 0.1$ ) without controls, and 0.079 (s.e. = 0.089,  $p = 0.19$ ) with controls.

#### IV. Turnout and Partisan Identification

We now turn to analyze different dependent variables: voter turnout and partisan identification. To analyze these behaviors, we must first specify how citizens make these political choices. Specifically, we posit an expressive voter model in which the expressive value of voting is increasing with a citizen's belief that one party's policy is better for her, and then move to examine the implications of this model theoretically and empirically.

<sup>27</sup>Note this is not an issue when age is used as a measure of the number of signals.



### A. Formalization

Turnout and partisan identification will depend on the policy positions adopted by parties. We assume that there are two parties committed to platforms  $L$  and  $R$ , with  $L = -R$ .<sup>28</sup> Denote by  $U_j(b_i|x)$  the utility that a citizen with preference bias  $b_i$  receives from the platform of party  $j$  when the state is  $x$ . Party  $R$ 's position will be better for citizen  $i$  in state  $x$  when  $U_R(b_i|x) > U_L(b_i|x)$ . As in the description above, we assume citizen  $i$  turns out to vote if and only if

$$(2) \quad \left| \Pr_i[U_R(b_i|x) > U_L(b_i|x)] - \frac{1}{2} \right| - c_i > 0,$$

where  $c_i \sim F_c$  is the idiosyncratic cost of turning out to vote. We assume  $F_c$  strictly increasing on  $(0, \frac{1}{2})$ , and  $c_i \perp (b_i, \rho_i, e_{it})$ . The online Appendix shows that (2) produces the same comparative statics as the canonical voting model of Riker and Ordeshook (1968) with a large electorate, and regret- or choice-avoidant voters (Matusaka 1995; Degan and Merlo 2011).<sup>29</sup>

Finally, we model strength of partisan identification using the left-hand side of (2), but with a (possibly different) distribution of costs  $F'_c$ .<sup>30</sup>

### B. Predictions

This model of turnout gives several predictions:

**PROPOSITION 7:** *Conditional on  $n$ :*

- (i) *More ideologically extreme citizens are more likely to turn out to vote.*
- (ii) *Conditional on overconfidence, more ideologically extreme citizens are more likely to turn out.*
- (iii) *More overconfident citizens are more likely to turn out, both conditional on, and independent of, ideological extremeness.*

*If  $\rho$  is large then these predictions also hold independent of  $n$ .*

The first part of Proposition 7 is a well-documented empirical regularity: more ideologically extreme citizens are more likely to turn out. The second part of Proposition 7 makes a stronger prediction: more ideologically extreme citizens are more likely to turn out, even controlling for overconfidence. The left panel of Figure 4 helps build intuition. It depicts the posterior of two citizens with the same level of

<sup>28</sup>Symmetric divergence can be generated from a Calvert (1985) model with policy and office motivated parties that are uncertain about the median voter's ideology due to the random realization of  $x$ .

<sup>29</sup>Note that Riker and Ordeshook (1968) contains both a pivotal and expressive component. In large elections the expressive component dominates. It is straightforward to see that (2) is consistent with regret-avoidance. As discussed in Degan and Merlo (2011), it is also consistent with choice-avoidance if voters will never learn whether their choice is correct or not. For a deeper discussion of these points, see the online Appendix.

<sup>30</sup>We adopt this formulation to simplify and shorten the exposition. Identical predictions are obtained from a more complex model of partisan identification discussed in the online Appendix.

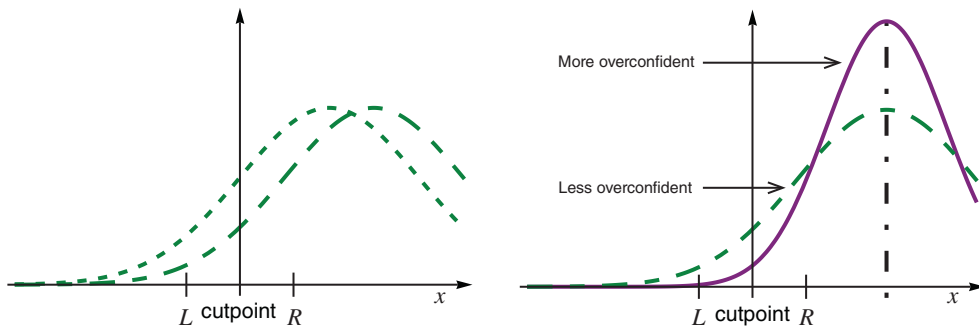


FIGURE 4. MORE IDEOLOGICALLY EXTREME, AND MORE OVERCONFIDENT CITIZENS ARE MORE LIKELY TO VOTE

overconfidence, but different ideologies. While both prefer  $R$  to  $L$ , the more extreme citizen assigns a higher probability to  $R$  having the correct policy, and hence is more likely to turn out.

The third part of Proposition 7 describes the role of overconfidence in turnout: more overconfident citizens are more likely to turn out, even controlling for ideology. The intuition is apparent from the right panel of Figure 4, which shows the posterior of two citizens, both with  $b = 0$  and the same posterior mean beliefs  $E_i[x]$ , but different levels of overconfidence. While both prefer  $R$  to  $L$ , the more overconfident citizen assigns a higher probability to  $R$  having the correct policy, and hence, is more likely to turn out.

Note that this provides an alternative explanation as to why right-leaning and older people are more likely to vote: because they are more overconfident. This contrasts with explanations in the literature that attribute these patterns to increased income changing the cost or benefits of voting, or even feelings of increased patriotism among those groups.<sup>31</sup>

The final predictions examined in the survey data concern the strength of partisan identification. These results follow directly from Proposition 7, as (2) characterizes both turnout and partisan identification.

**COROLLARY 1:** *Conditional on  $n$ , strength of partisan identification is increasing in overconfidence, both conditional on, and independent of, ideological extremeness. Moreover, strength of partisan identification is increasing in ideological extremeness, both conditional on, and independent of, overconfidence. If  $\rho$  is large enough, these results hold independent of  $n$ .*

### C. Empirical Analysis

We examine Proposition 7 using verified voter turnout from the 2010 CCES.<sup>32</sup> The results, shown in Table 7, are supportive of the proposition: columns 3 and 4

<sup>31</sup> We thank an anonymous referee for pointing this out.

<sup>32</sup> One of the advantages of the CCES dataset is that it provides verified voter turnout in addition to self-reported turnout, which is known to be unreliable. Our results also hold, and indeed are stronger, if we use self-reported turnout.

TABLE 7—TURNOUT IS INCREASING WITH OVERCONFIDENCE AND IDEOLOGICAL EXTREMENESS

Turnout decision								
Overconfidence	0.096*** (0.017)	0.056*** (0.017)	0.61*** (0.015)	0.068** (0.017)	0.066*** (0.017)	0.026* (0.016)	0.029* (0.016)	0.014 (0.015)
Ideological Extremeness		0.18*** (0.014)				0.14*** (0.016)		0.13*** (0.015)
Economic controls			Yes				Yes	Yes
Media (16 categories)				Yes		Yes	Yes	Yes
Age (73 categories)					Yes	Yes	Yes	Yes
$R^2$	0.037	0.16	0.18	0.11	0.18	0.29	0.31	0.36
Observations	2,808							

Notes: Standard errors, clustered by age (73 clusters), in parentheses. All specifications estimated using WLS with CCES sampling weights.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

show that more ideologically extreme citizens are more likely to vote, even conditional on overconfidence; and more overconfident citizens are more likely to vote, even conditional on ideological extremeness.<sup>33</sup> Moreover, in columns 5–7, we show that these patterns hold even conditioning on the number of signals,  $n$ . However, when the economic controls are added to all of the theoretical controls, in column 9, the result remains positive, but loses statistical significance.

To get a full accounting of the effect of overconfidence on turnout, we need to first account for the fact that overconfidence also leads to ideological extremeness. Doing so, a one standard deviation increase in overconfidence is associated with a 15–19 percent (depending on the specification) increase in turnout: a 7.5–9.5 percentage point increase versus a baseline turnout rate of 51 percent in the data. This effect is substantively important as it is larger than the effect of income, education, union membership, and over half of the effect size associated with ideological extremeness and age—all known to be important correlates of turnout.

We now examine partisan identification. As noted in Section IIB, we construct three measures of partisan identification, all of which code someone who identifies as a “Strong Democrat” or “Strong Republican” as a strong partisan identifier (1), and most others as weak partisan identifiers (0). The three measures differ in how they treat those who identify as “independent.” The first matches theory and codes independents as weak partisan identifiers (0). However, it has been suggested that independents may also hold strongly to that identity, so we show that our results are robust to this possibility, first by coding them as strong partisan identifiers (1), and then by dropping these respondents ( $\cdot$ ).

Table 8 then regresses these measures on overconfidence, ideological extremeness, economic controls, and controls for the number of signals. The results are consistent with theory, no matter which measure is used. Doing the same accounting

<sup>33</sup> Ideological extremeness here is not purged of economic effects, as our theoretical results are stated conditional on extremeness, not extremeness without wealth or income effects. Using the purged measure produces nearly identical results.

TABLE 8—OVERCONFIDENCE IS CORRELATED WITH STRENGTH OF PARTISAN IDENTIFICATION, EVEN CONTROLLING FOR IDEOLOGICAL EXTREMENESS AND NUMBER OF SIGNALS

	Strength of partisan identification				
<i>Panel A. Independents treated as weak partisan identifiers (0)</i>					
Overconfidence	0.052*** (0.013)	0.049*** (0.013)	0.027* (0.014)	0.040*** (0.013)	0.030** (0.014)
Ideological extremeness			0.11*** (0.015)		0.12*** (0.014)
Economic controls		Yes			Yes
Number of signals				Yes	Yes
$R^2$	0.012	0.084	0.062	0.085	0.18
Observations			2,868		
<i>Panel B. Independents treated as strong partisan identifiers (1)</i>					
Overconfidence	0.049*** (0.016)	0.056*** (0.014)	0.038** (0.016)	0.034** (0.016)	0.037** (0.014)
Ideological extremeness			0.052*** (0.015)		0.066*** (0.015)
Economic controls		Yes			Yes
Number of signals				Yes	Yes
$R^2$	0.0097	0.074	0.020	0.081	0.15
Observations			2,868		
<i>Panel C. Independents treated as missing data (·)</i>					
Overconfidence	0.060*** (0.015)	0.062*** (0.014)	0.038** (0.016)	0.044*** (0.014)	0.039*** (0.014)
Ideological extremeness			0.10*** (0.017)		0.11*** (0.015)
Economic controls		Yes			Yes
Number of signals				Yes	Yes
$R^2$	0.015	0.098	0.054	0.091	0.19
Observations			2,545		

Notes: Standard errors, clustered by age (73 clusters), in parentheses. All specifications estimated using WLS with CCES sampling weights.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

exercise as above, a one standard deviation change in overconfidence is associated with a 9–15 percent increase in the probability a respondent classifies themselves as strongly partisan: a 4.5–6 percentage point increase from a mean rate of 36 percent, 42 percent, and 51 percent, respectively, for the three different measures. This is 45–95 percent of the effect size associated with ideological extremeness. Note again that the controls that strongly affect the results are those that have a theoretical role—ideological extremeness, age, and media exposure.

One other pattern in Table 8 is worth noting: ideological extremeness is a worse predictor of strength of partisan identification when independents are treated as strong partisan identifiers. Intuitively, there are few respondents who hold extremely conservative or liberal views, but identify as independent.

## V. Other Sources of Information

In this section we examine how relaxing our assumptions about the sources of information would affect our primary results. First, we consider the case in which citizens choose the number of costly signals to acquire. Second, we consider the effects of citizens sharing their ideologies with each other. In both cases we find that these extensions strengthen our results.

### A. Endogenous Information Acquisition

In standard models, risk-averse citizens acquire information to reduce their uncertainty about the state  $x$ . In these models, more confident citizens would demand fewer signals—in our context, less media. However, in our model more overconfident citizens acquire *more* information. Moreover, endogenizing information acquisition strengthens our primary result.

To formalize, define the cost of acquiring a signal as  $c$ , and a citizen's perceived optimal number of signals as  $n_i^*$ . Further, define  $V_i(\kappa_i | n_i)$  as the value to citizen  $i$ , with overconfidence  $\kappa_i$ , of an additional signal, given that she has already received  $n_i$  signals. Then:

PROPOSITION 8:

- (i)  $V_i(\kappa_i | n_i)$  is increasing in  $\kappa_i$ .
- (ii)  $n_i^*$  is increasing in the degree of correlational neglect.

The first part of Proposition 8 may seem counterintuitive: why would someone who believes they are more certain of the state place a greater value on the additional information? The intuition comes from the second part: as more overconfident citizens neglect correlation to a greater degree, they believe additional signals have more information, and thus value.

The second part of Proposition 8 is consistent with the first panel of Figure 1: media exposure is increasing in overconfidence. It also has an additional implication: endogenizing media exposure reinforces the relationship between overconfidence and extremeness found in Proposition 2. This occurs because those with a greater degree of correlational neglect are now more overconfident and more extreme for two reasons: correlational neglect and increased media consumption.

### B. Communication between Citizens

What if citizens could learn the point of view of citizens outside their network, or receive information from public sources? In this subsection, we show theoretically that this would, interestingly, strengthen the correlation between overconfidence and ideological extremeness. This occurs because when more overconfident citizens meet someone with a different ideology, they attribute this difference to factors other than the information possessed by the other citizen—as, by construction, they believe that “they know better.” Therefore, more overconfident citizens will tend

to update less than less overconfident citizens, making more overconfident citizens relatively more extreme.

We illustrate this pattern in two ways. First we consider citizens with arbitrary preference biases,  $b_i$ , who are unaware that other citizens may be overconfident. Second, citizens are aware that others may be overconfident, but there are no preference biases ( $b_i = 0, \forall i$ ). In the first case, citizens will attribute disagreement to the bias of others; in the second, they will attribute it to others' overconfidence. More overconfident citizens will attribute more of the difference to these other factors.

Throughout this section, we assume that after  $n$  private signals, each citizen  $i$  meets another, randomly chosen, citizen  $j$  and is told her ideology. It is straightforward to extend the analysis to citizens meeting any finite number of other citizens, or observing any finite number of public signals with known precision.<sup>34</sup>

*Unawareness of Overconfidence.*—As noted above, we begin by assuming citizens are unaware of overconfidence.

**PROPOSITION 9:** *When citizen  $i$  is told the ideology of citizen  $j$ , and she believes  $\kappa_j = \kappa$ :*

- (i) *The ideology of citizen  $i$  after communication is  $\alpha_i \mathcal{I}_i + \beta_i \mathcal{I}_j$  for some  $\alpha_i, \beta_i \in \mathbb{R}_{++}$ , where  $\alpha_i$  is increasing in  $\kappa_i$  and  $\beta_i$  is decreasing in  $\kappa_i$ .*
- (ii) *If  $\mathcal{I}_j \neq (\mathcal{I}_i - b_i) \frac{\kappa}{\kappa + \tau}$ , then  $i$ 's mean belief about the extremeness of  $j$ 's preferences is increasing in  $i$ 's level of overconfidence,  $\frac{d|E_i[b_j]|}{d\kappa_i} > 0$ .*

When  $i$  meets  $j$ , she knows that the difference in their ideologies may have two sources: different preference biases and different information. The more overconfident citizen  $i$  is, the more confident she is that she and  $j$  received similar signals. Thus, she believes their difference in ideologies is due to differences in preference biases. In turn, this leads  $i$  to only slightly update her beliefs.

This intuition also characterizes how overconfident citizens would update in the face of media reports contradicting their point of view. As long as there is some chance that the media is biased, more overconfident citizens will attribute the contradiction to media bias, and, hence, update less.

*No Preference Biases.*—Next, we consider the case in which citizens are (correctly) aware of the fact that others are overconfident. For simplicity, we assume that all citizens have no preference bias ( $b_i = 0, \forall i$ ), and that this is common knowledge.

<sup>34</sup> Matching with like-minded individuals is encompassed by correlational neglect. If there is uncertainty about the distribution of overconfidence in the population, or the mean preference bias in the population, our results extend to public signals regarding the distribution of ideology.



Define  $F_{\kappa_i}$  as the distribution of posterior precisions in the population, and  $\underline{\kappa} = \inf\{y | F_{\kappa_i}(y) > 0\}$ , then:

**PROPOSITION 10:** *Suppose  $b_i = 0, \forall i$ . When citizen  $i$  is told the ideology of citizen  $j$ :*

- (i) *The ideology of citizen  $i$  after communication is  $\gamma_i \mathcal{I}_i + \delta_i \mathcal{I}_j$  for some  $\gamma_i, \delta_i \in \mathbb{R}_{++}$ , where  $\gamma_i$  is increasing in  $\kappa_i$  and  $\delta_i$  is decreasing in  $\kappa_i$ .*
- (ii)  *$E_i[\kappa_j]$  is increasing in  $\kappa_i$  if  $i$  and  $j$  are on opposite sides of the aisle, ( $\mathcal{I}_i \times \mathcal{I}_j < 0$ ) or if  $j$  is more ideological extreme than  $i$  ( $\mathcal{E}_j > \mathcal{E}_i$ ).*
- (iii)  *$E_i[\kappa_j]$  is decreasing in  $\kappa_i$  if  $i$  and  $j$  are on the same side of the aisle ( $\mathcal{I}_i \times \mathcal{I}_j > 0$ ), and  $\mathcal{E}_i > \frac{\tau + \underline{\kappa}}{\underline{\kappa}} \mathcal{E}_j$ .*

Proposition 10 has a similar form, and intuition, to Proposition 9. When a citizen meets someone with a different ideology, she can attribute the difference to either differences in information, or in how the other citizen processes information. Following the logic above, more overconfident citizens attribute more of the difference to other citizens' overconfidence.

However, the other parts of Proposition 10 are more nuanced. In particular, if the other citizen is more extreme, or is on the other side of the aisle, the first citizen attributes this to overconfidence. But when the other citizen is on the same side of the aisle but is less extreme, the first citizen believes that the other underinterprets her information: that is, she "lacks the courage of her convictions."

Proposition 9 and 10 both imply that communication causes more overconfident citizens to have *relatively* more dispersed ideologies. This leads to a greater correlation between overconfidence and ideological extremeness.

Finally, these results allow us to briefly consider a puzzle presented in the introduction: why political rumors and misinformation are so persistent. Our model suggests a possible answer: it is very difficult to persuade overconfident citizens that their prior is incorrect, as they tend to attribute contradictory information to others' biases.

## VI. Discussion: Identification and Future Directions

We conclude with a summary of our major results, and then turn to a discussion of identification and directions for future research.

This paper introduces a model of correlational neglect leading to overconfidence, and draws implications for political behavior. In particular, the model predicts that overconfidence and extremism are positively correlated, that both overconfidence and ideological extremism are independently correlated with voter turnout, that overconfidence is increasing with the number of signals—that is, age and media exposure—and that, moreover, the correlation between ideology and overconfidence is increasing in the number of signals. Taking into account the findings of Section IIIA, the model makes additional predictions: ideology and overconfidence are positively correlated, the covariance between extremism and overconfidence is

greater for those right-of-center than left-of-center, and that the covariance between media exposure and the number of signals is greater for those right-of-center than left-of-center. These implications are examined using unique survey data. All find support in this data, most at very high levels of statistical significance, and when controlling for the number of signals and all available economic factors.

### A. Identification

For our results to be identified, correlational neglect must be something akin to a personality trait: set early in life, with changes unrelated to political conditions. While this is plausible, it is not testable with our data. However, we can gain deeper insight by considering two classes of threats to identification: reverse causality and third-factor causation.

One might object that the factual questions used to measure overconfidence are inherently ideological, and thus extremeness causes confident responses. While Ansolabehere, Meredith, and Snowberg (2014) do not find partisan differences in factual answers, we have also examined other ways of eliciting overconfidence. Specifically, we were allowed to place a few questions on the 2011 CCES that would measure overconfidence on general knowledge items, such as the year of Shakespeare's birth and the population of Spain. Moreover, confidence was elicited using a confidence interval, similar to the method used in the psychology literature. While the 2011 survey is limited in other ways—it was much shorter and smaller, only allowed for self-reported ideology, and did not contain voter turnout data—we can use it to examine the central relationship between extremeness and overconfidence.

Table 9 shows that the results are substantively unchanged in the 2011 data, and that the results using the different measures of overconfidence are statistically indistinguishable.<sup>35</sup> We believe this should eliminate concerns that the correlation between extremeness and overconfidence is driven by the questions we use to measure overconfidence.

However, there may be *something else* causing both ideology and overconfidence: for example, particular patterns of brain or social development. To our knowledge, the literature does not suggest any obvious third factors that would explain all of our empirical findings. If such a third factor is found, it would clearly be very important. Even if that occurs, we believe our results will still provide useful insights into the relationship between overconfidence and political characteristics. Indeed, as correlational neglect is a third factor in this sense, it may turn out that this *something else* is a set of mechanisms underlying correlational neglect.

### B. Future Directions

This returns us to the introduction, where we noted two puzzles, and suggest that a behavioral basis for ideology promises to deepen our understanding of political institutions. The first puzzle was why political polarization has seemed to increase

<sup>35</sup>To reduce bias due to measurement error, we can instrument one measure with the other. This increases coefficients by approximately a factor of three (see Ortoleva and Snowberg forthcoming).

TABLE 9—A GENERAL KNOWLEDGE-BASED MEASURE OF OVERCONFIDENCE PRODUCES THE SAME RESULTS

	Self-reported ideological extremeness ("don't know" treated as centrist)			
Overconfidence (economy)	0.16*** (0.047)	0.11*** (0.040)		
Overconfidence (general knowledge)			0.17*** (0.043)	0.12** (0.050)
Economic controls		Yes		Yes
Number of signals		Yes		Yes
$R^2$	0.024	0.32	0.030	0.32
Observations		989		

Notes: Standard errors, clustered by age (69 clusters), in parentheses. All specifications estimated using WLS with CCES sampling weights.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

with an increase in access to information. As noted in Section IIIA, our theory provides a potential answer: if additional signals are correlated such that the increase in the number of signals is greater than the increase in information, this will lead to greater polarization. The second puzzle concerned the durability of political rumors and misinformation. As noted at the end of Section VB, a related mechanism may be responsible: overconfident citizens will tend to attribute contradictory information to the biases of others rather than to their own misinformation.

Understanding how these patterns interact with institutions must be left to future work, however, we illustrate the usefulness of our findings by sketching a model of primaries with overconfident voters (Ortoleva and Snowberg 2015b). Two parties have primaries to nominate candidates for executive office. Between the primaries and the general election, nature will send each voter a signal of the state. It is well known that primary voters are more ideologically extreme than the general electorate. Based on the evidence presented above, these voters are also more overconfident. Thus, although primary voters know the ideology of the median voter at the time of the primary, they expect nature's signals to agree with their beliefs, drawing the median voter toward their ideology. This implies that primary voters will select candidates on opposite sides of the median voter, expecting nature's signal to pull the median voter toward the more extreme position of the primary voters. Moreover, the losing candidates' partisans will think the median voter ignored "the truth." We believe this sketch provides some insight into the nomination of, and partisan reactions to the defeat of John Kerry in 2004 and Mitt Romney in 2012.

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