Confidence and Overconfidence in Political Economy*

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Abstract

This paper studies the role of overconfidence in political behavior. We posit a simple model of overconfidence in beliefs. The model predicts that overconfidence leads to ideological extremeness, increased voter turnout, and increased strength of partisan identification. Moreover, the model makes many nuanced predictions about the patterns of ideology in society, and over a person's lifetime. These predictions are tested, using novel survey data that allows for the measurement of overconfidence, and are found to be statistically and substantively important.

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1 Introduction

Ideological differences play a central role in many political economy models. As ideology is often interpreted as political preferences, little work in economics has gone into explaining its roots. However, both colloquially and academically, ideology has also been construed as a form of belief, opening the door to examining how these beliefs come about, and how well-known behavioral biases may influence them (McMurray, 2012).

This paper shows theoretically that overconfidence leads to the formation of extreme political beliefs—ideology—as well as higher turnout and stronger attachment to parties. The predictions of our model find support in unique survey data from the 2010 Cooperative Congressional Election Survey (CCES).

Overconfidence is a well-know behavioral bias that has been successfully used by behavioral and financial economists to explain many behaviors (see, for example, Odean, 1998; Daniel, Hirshleifer and Subrahmanyam, 1998; Camerer and Lovallo, 1999; Santos-Pinto and Sobel, 2005). Moreover, some economists have shown that overconfidence may be advantageous, especially in political settings (for example Benabou and Tirole, 2002, 2006; Benabou, 2008). We expand on these literatures by analyzing the implications of overconfidence for political behavior.

In our model of ideology formation, citizens passively learn about the state of the world through their experiences. However, to varying degrees citizens fail to understand how correlated these experiences are, and thus, have different levels of confidence about how representative their experiences are of the true state of the world. For example, a citizen may note the number of people in their neighborhood who are unemployed, and use this information to deduce the state of the national economy. However, if the citizen neglects the fact that he lives in a city with a high-level of unemployment—for example, Detroit in 2009—and interprets each unemployed individual as an independent signal of the national economic situation, he will be extremely confident that the national economic situation is quite dire, and perhaps favor generous aid to the unemployed and loose monetary policy. If, on the other hand, he realizes that all of these experiences have a common cause, say a factory shutting down, then he will realize that he has comparatively little information about the national economic situation, and believe that although the situation is bad, it is not likely to be dire. This prediction, that overconfidence and ideology are correlated, is supported by our data.

The model makes additional predictions about the structure of ideology in society. First, it predicts that older citizens will be more overconfident, and will generally be more ideologically extreme. This prediction is supported by our data. Moreover, the theory predicts that if more overconfident citizens are, on average, more conservative, ideology should be more correlated with overconfidence for conservatives than for liberals. This appears to be the case in more recent years in the US, but poor-quality historical data is consistent with overconfidence being correlated with ideological extremeness on both the left and the right.

To extend the model to voter turnout, we follow Matsusaka (1995) and Degan and Merlo's (2011) modification of the canonical model of voter turnout, due to Riker and Ordeshook (1968). In their modification, citizens prefer to vote for the party or candidate whose policy is more likely to be better for them, given the true state of the world. If, however, neither party is much more likely to be better for them, they abstain. Similarly, we model strength of partisan identification as the probability a citizen places on their favored party's policy being better for that citizen. This is consistent with a large literature in psychology and behavioral economics that documents regret and choice avoidance.

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 turnout to vote *even conditional on ideology*. The opposite conditional statement is also true: more ideologically extreme citizens are more likely to vote, even conditional on overconfidence. This means that our model matches the well-known regularity that more ideological people are more likely to vote. The more nuanced predictions are also supported: overconfidence is correlated with turning out to vote, even controlling for ideological extremeness.

The paper is structured so that each set of predictions is quickly tested using survey data. Most tests are conducted using a unique dataset, collected as part of the 2010 Cooperative Congressional Election Study. This data allows for a measure of overconfidence that resembles those generally used in psychology. As noted above, the data indicates that overconfidence is related to ideological extremeness, voter turnout, and strength of partisan attachment. These empirical relationships are both substantively and statistically important, even when controlling for a number of other factors.

1.1 What is Overconfidence?

Overconfidence describes a few related phenomena that share the general characteristic that a person thinks some attribute of his or hers, usually information or performance, is better than it actually is. Moore and Healy (2007, 2008) divide overconfidence into three categories that are conflated in most studies: over-estimation, over-placement, and over-precision. Over-estimation is the tendency of subjects to believe that they perform better at a task than they actually did. Over-placement is the tendency of subjects to believe that they performed better than others—as in the classic statement that, "93% of drivers believe that they are better than average."[1]

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, this is not the case for over-precision.[2] That is to say, (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 and politics than they actually are. Despite our focus on over-precision, following wide-spread (mis-)usage, we generally use the term overconfidence.

Overconfidence, as described above, can be either modeled directly, or, we show, as the consequence of correlational neglect.[3] That is, similar to the example in the previous subsec-

[1] Interestingly, this may be a perfectly rational, see Benoît and Dubra (2011).

[2] Extensive research shows that over-estimation and over-placement suffer from reversals: people tend to perceive themselves as better than they really are when a task is easy, and worse than they actually are when the task is difficult (Erev, Wallsten and Budescu, 1994).

[3] Correlational neglect has recently been implicated in (poor) financial decision making (Eyster and

tion, a citizen has many experiences, which they believe to be relatively uncorrelated signals of the state of the world. However, he neglects that these experiences are all happening to him, and thus are highly correlated. The more that a citizen ignores this correlation, the more precise a signal the citizen believes he has received.[4]

It is worth noting that overconfidence is the subject of a large literature, having first been documented (in the form of over-precision) by Alpert and Raiffa (1969/1982).[5] That literature has documented overconfidence in a wide range of contexts, and among people from a wide range of backgrounds and countries. There are two robust findings that are relevant here. First, men are more overconfident than women (for example, Lundeberg, Fox and Punćcohař́, 1994). Second, previous studies treat overconfidence as something akin to a personality trait, that is, it seems to be generally believed that some people are simply more overconfident than others.

1.2 Literature

This work contributes to the emerging literature on behavioral political economy, which applies behavioral findings to deepen our understanding of the causes and consequences of political behavior (Bendor, Diermeier and Ting, 2003; Callander and Wilson, 2006, 2007, 2008; Bendor et al., 2011; Bisin, Lizzeri and Yariv, 2011). Of particular interest to economists may be the fact that many of the feedback mechanisms that have lead scholars to doubt the importance of behavioral models in markets do not exist in politics. Moreover, behavioral traits that may be detrimental in markets may be useful in facilitating collective action (Benabou and Tirole, 2002, 2006; Benabou, 2008).

Moreover, behavioral political economy has the potential to provide a framework to integrate the insights of a half-century of psychology-based political behavior work into

Weizsäcker, 2011)

[4]DeMarzo, Vayanos and Zwiebel (2003) study a model of networks where people exchange messages and update their beliefs on the basis of the messages they receive. In their model, people do not take into account that correlation between multiple messages from the same people, and opinion collapses to a single dimension.

[5]Moreover, some international relations scholars have embraced overconfidence as a likely cause of some wars (Fearon, 1995; Johnson, 2004).

political economy. In our case, ideology, voting, and partisan attachment are the subject of a massive political science literature. The work here is most closely related to two sub-literatures. First, it is most closely related to the (small) bayesian literature in political behavior. In particular, we modify the normal learning model to incorporate over-precision.[6] This is a novel approach to modeling overconfidence. Moreover, we provide a way to measure overconfidence on surveys.

Second, the paper is related to the literature that strives to understand how political behaviors are tied to personality traits. Recent work in this literature has focused on the "Big Five" personality traits (see, for example Gerber et al., 2010, 2011). Overconfidence is often seen as akin to a personality trait, as it seems to be relatively stable over time. However, over-confidence (specifically over-precision) is often found to be orthogonal to the "Big Five" personality traits (Moore and Healy, 2007). Thus, the research described here is complimentary to this literature.

In the economics literature, our model of ideology is most closely related to Blomberg and Harrington (2000), which studies a model in which citizens have priors with heterogeneous means and precisions. Citizens all observe public signals of the true state of the world. Those that start with extreme and precise beliefs end up retaining those beliefs, while those with extreme and imprecise beliefs converge to the center. While similar in some respects to our model, there are substantive differences. For example, Blomberg and Harrington (2000) predicts that older citizens should be less ideologically extreme. However, consistent with our model, in our data older people are more ideologically extreme. Our model of turnout follows Matsusaka (1995) and Degan and Merlo (2011), which explain turnout and roll-off respectively as being due to either regret or choice avoidance. However, these models focus on uncertainty about candidates' policies, rather than uncertainty about the effects of those policies as in our model, and classic models like Crawford and Sobel (1982); Gilligan and Krehbiel (1987).

[6] Although the literature is not large, it cannot be completely reviewed here. Early papers include Zechman (1979); Achen (1992), and others. For a recent review, see the introduction of Bullock (2009).

2 Framework

This section, like those that follow, lays out theory and then immediately moves to data corresponding to the theory. We establish the fundamentals of our model, and define precisely define overconfidence. This is followed by a discussion of the data we have available, and how we use it to construct measures of overconfidence, ideology, and the other theoretical variables discussed in the paper.

2.1 Theoretical Framework

There is a unit measure of citizens $i \in [0, 1]$. Each citizen i has a utility for actions which depends on the state of the world. Moreover, each citizen has beliefs over the state of the world. These beliefs are determined by a citizen's experiences.

Utilities: Each citizen i is endowed with a standard quadratic-loss utility over actions $a_i \in \mathbb{R}$, which depends on the state of the world $x \in \mathbb{R}$, and a preference bias b_i

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

That is, for a given state of the world, a citizen's utility is maximized by setting $a_i = b_i + x$. The action a_i may be any political action, such as giving a speech, but throughout this paper it is the policy that a citizen would like to see implemented by government.

Citizens are uncertain about the actual state of the world. We postpone briefly a discussion of the origin of citizens' beliefs, and for now assume that citizen i's beliefs are given by some c.d.f. $F_i(x)$. The citizen wants to set a_i to maximize utility, that is, they solve:

$$\max_{a_i} \int U(a_i, b_i|x) dF_i(x) \quad = \quad \max_{a_i} \quad - (a_i - b_i - \mathbb{E}_i[x])^2 - \frac{1}{\tau_{F_i}}$$

where τ_{F_i} is the precision of $F_i(x)$, and hence $1/\tau_{F_i}$ is the variance of $F_i(x)$. Note that the policy preferred by citizen i will be $a_i = b_i + \mathbb{E}_i[x]$.[7] We define this quantity as the ideology $\mathcal{I}$ of the citizen, thus

$$\mathcal{I}_i = b_i + \mathbb{E}_i[x]. \tag{1}$$

Note that in this framework one cannot distinguish the role of the preference bias and beliefs in ideology.

Preference Bias: Citizens differ in terms of their preference bias b_i. This bias is an i.i.d. draw from a normal distribution with mean π_b and precision τ_b. We write this as

$$b_i \sim \mathcal{N}\left[\pi_b, \tau_b\right].$$

For simplicity, we normalize $\pi_b = 0$ throughout.

Experience and Beliefs: The core of the model is the process by which citizens form beliefs over the state of the world. In our model, each citizen is well-calibrated about the informativeness of individual experiences, but underestimates how correlated his experiences are. This will lead to varying degrees of over-confidence in the populace.

Each citizen starts with a normal prior $\mathcal{N}\left[\pi, \tau\right]$ over the state of the world, which has a common mean π, and a common precision τ. For simplicity, we normalize $\pi = 0$ throughout.[8]

Citizens have multiple experiences over time, which are signals about the state of the world, $e_{it} = x + \varepsilon_{it}$, $t \in \{1, 2, \ldots, n\}$. The error ε_i is distributed according to a mean-zero

[7] The expectation here is taken over the measure F_i. $\mathbb{E}_i[\cdot]$ is an abuse of notation meant to convey this.

[8] All of our results hold when $\pi_i|\kappa \sim \mathcal{N}[0, \tau_\pi]$ and $\tau|\kappa \sim F_\tau(\cdot)$ over $[\underline{\tau}, \overline{\tau}] \in (0, \infty)$. We refrain from introducing these complications as they do not add to the testable predictions of the model. Overconfidence κ will be defined below.

multinomial normal with covariance matrix

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

where each citizen has a $\rho_i \in [0, \rho)$ which is an i.i.d. draw from some c.d.f. F_ρ. Note that as each ε_{it} has unit variance, the covariance between any two signals is the same as the correlation, ρ.

Intuitively, when $\rho_i < \rho$ a citizen underestimates, or neglects, the amount of correlation between his or her experiences. In particular, when $\rho_i = 0$ and $\rho = 1$, the citizen will have the same experiences over and over again, but believe each experience provides completely new information about the state of the world. To an outside observer, it would be as if the citizen had received a single signal, but had interpreted it as being twice as precise as it actually was, and the citizen's posterior beliefs would be too precise: that is, the citizen would be overconfident.[9]

As we only have data on overconfidence—and not a citizen's level of correlational neglect—we formalize this concept, before discussing the data. Define the precision of citizen i's posterior belief as τ_{ρ_i}, and the posterior belief they would have if they had proper beliefs about the correlation between signals as $\tau_{\rho,i}$.

Definition 1 *The* **confidence** *of citizen i is given by τ_{ρ_i}.*
We say that a citizen i is **overconfident** *if $\kappa_i \equiv \tau_{\rho_i} - \tau_{\rho,i} > 0$.*
Given two citizens i and j, we say that i is **more overconfident** *than j if $\kappa_i \geq \kappa_j > 0$.*

2.2 Data

[9]Alternatively, we could model the state of the world in a multi-dimensional space with multi-dimensional errors over time, and citizens either underestimate the amount of correlation between dimensions, or across time, or both. This produces similar results throughout. For simplicity, we restrict ourselves to a single-dimensional issue space.

The data used in this paper comes from two different sources. The first source, the Harvard and Caltech modules of the 2010 Cooperative Congressional Election Study (CCES) is unique (as far as we are aware) in that it allows a survey-based measure of overconfidence in beliefs. Unfortunately, it is just a single cross-section of responses. Therefore we supplement this data with analyses, in Section 3.3, from the American National Election Study (ANES) cumulative data file, which has greater coverage across time, but no measure of overconfidence. As the ANES data is well-known, this section focuses on the data from the CCES.

The CCES is an annual cooperative survey. Participating institutions purchase a "module" of at least 1,000 responses to 10–15 minutes of survey questions. In addition, every respondent across all modules are asked the same battery of basic demographic and political questions. The complete survey is administered on-line by Knowledge Networks. The survey strives to be nationally representative across each module by balancing on demographics.

2.2.1 Overconfidence

The most important feature of this data is that it allows for a measure of overconfidence. This is constructed from four questions about respondent confidence in their guesses about four factual quantities, adjusted for how accurate a survey respondent's answers to the factual questions are. In particular, as part of another set of studies, respondents were asked their assessment of the current unemployment and inflation rate, and their assessment of what the unemployment and inflation rate would be a year from the date of the survey (Ansolabehere, Meredith and Snowberg, 2011, 2012).

After each factual question, respondents were asked their confidence about their answer to the factual question. In particular, they were asked:

> How confident are you in your estimate?
>
> - No confidence at all
> - Not very confident
> - Somewhat unconfident
> - Somewhat confident

- Very confident
- Certain

with the first response coded with the numeric value 1, and the final with a numeric value 6.

We use the first principal component of the answers to these four questions as a measure of confidence.[10] However, a respondent's confidence reflects both their knowledge about the subject area in question, as well as overconfidence. In order to transform our measure of confidence into a measure of overconfidence, we regress the confidence measure on a fourth order polynomial of respondent accuracy in assessing each of the four of the factual questions (16 variables in all).[11] The residual from this regression is thus purged of a respondent's actual knowledge about unemployment and inflation rates, and thus can be used as a measure of overconfidence. To make regression coefficients easily interpretable, we divide the resulting measure by its standard deviation.

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 trivia questions—for example, "When was Shakespeare born?" Second, we ask about confidence directly, while studies in psychology typically elicit actual confidence intervals.[12] To understand whether our slightly different approach might make it difficult to compare our findings to previous findings, we added four trivia 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 test in the (more limited) 2011 CCES still hold using more traditional measures of overconfidence. More detail can be found in the Appendix.[13]

[10]Responses to these questions are highly correlated and all of the results hold using any one of the four questions in isolation. The first principal component weights each of the four questions approximately equally, and explains 66% of the variance.

[11]In keeping with the treatment of these factual questions in Ansolabehere, Meredith and Snowberg (2011, 2012), we topcode responses to the unemployment and inflation questions at 25. This limits how inaccurate a respondent can be. We are able to assess the accuracy of respondents' assessments of future unemployment and inflation rates as these analyses were done more than a year after the data were collected.

[12]In addition, most studies in psychology ask a much larger number of questions (up to 150). (see, e.g. Alpert and Raiffa, 1969/1982; Soll and Klayman, 2004). Whether confidence intervals can be used on surveys (as opposed to the highly selected, and quite sophisticated subjects in most psychology experiments) is an

Table 1: Overconfidence is correlated with gender and race, but not education or income.

	Dependent Variable: Overconfidence					
Gender (Male)	0.49*** (.036)	0.48*** (.036)	0.48*** (.036)	0.48*** (.036)	0.48*** (.037)	0.48*** (.036)
Race (Black)		-0.14** (.059)				
Education			$F = 1.06$ $p = 0.38$	0.0037 (.013)		
Income					$F = 0.91$ $p = 0.56$	0.0068 (.0046)
N			2,927			

Notes: ***, **, * denote statistical significance at the 1%, 5% and 10% level with standard errors in parenthesis.

In keeping with previous research, this measure is strongly correlated with a respondent's gender, as shown in Table 1. It is also correlated with a respondent's race. However, overconfidence is uncorrelated with education or income, providing some confirmation that actual knowledge has been purged from this measure. Note that as discussed in Section 2.2.3 these latter variables are categorical, but ordered. As such we present both F-tests, and regression results. The latter show that the point estimates of the coefficients on education and income are small.

2.2.2 Dependent Variables

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

open question (see, e.g. Juslin, Wennerholm and Olsson, 1999; Rothschild, 2011).

[13]Note that the data we use to elicit overconfidence is similar to that used in psychology. However, there are several important differences. In particular, psychology studies typically elicit actual confidence intervals, and do so for a very large number of factual questions: up to 150 (see, e.g. Alpert and Raiffa, 1969/1982; Soll and Klayman, 2004). Whether confidence intervals can be used on surveys (as opposed to the highly selected, and quite sophisticated subjects in most psychology experiments) is an open question (see, e.g. Juslin, Wennerholm and Olsson, 1999; Rothschild, 2011). The appendix contains some preliminary data on this question. Note that the method we use to control for information of respondents is more conservative than those used in psychology, see Moore and Healy (2007, 2008).

Ideology: This study uses three different measures of ideology. The first is the scaled ideology measure used in Tausanovitch and Warshaw (2011), which they graciously provided to us. This measure is generated by using item response theory (IRT) to scale responses to eighteen 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). One particular feature of this measure is worth noting here: on issue questions with more than two possible answers, the possible answers are split into two groups, one group of answers being coded as for, the other against.[14] That is, respondents who give more extreme responses are coded the same way as those who give a more moderate response in the same direction. This eliminates concerns that our results concerning ideological extremeness are driven by respondents who simply like to choose extreme answers on surveys.

We also employ two measures of self-reported ideology. The CCES twice asks respondents to report their ideology: from extremely liberal to extremely conservative. The first elicitation is when the subject 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 be on the interval $[-1, 1]$, and then average them. Those that report they "don't know" are either dropped from the sample, or treated as moderates (0). Results are presented for both treatments of those that "don't know". These self-reported measures are imperfectly correlated with scaled ideology (0.44).

To generate measures of ideological extremeness, these measures are folded around the midpoint of the ideological scale. All three measures of ideology and ideological extremeness are divided by their standard error to make regression coefficients directly interpretable.

Turnout: Turnout is whether a survey respondent was later found to have voted in the primary or general elections in 2010, according to the voting rolls of the state that he or she lived in. Voter rolls vary in quality between states, but rather than trying to control for this

[14]If an issues question had an odd number of responses, the middle response is randomly coded as either for or against for all respondents.

directly, we include state fixed effects in most of our specifications.[15]

Partisan Identification: At the time of the survey, respondents are asked whether they identify with the Republican or Democratic Party, or consider themselves to be an independent. 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 that report that they are an independent are asked if they lean to one party or the other, and are allowed to say that they do not lean towards either party. Those that report they are a strong Democrat or Republican are coded as strong partisan identifiers. Independents (those that do not lean towards either party) are coded as either strong party identifiers, weak party identifiers, or left out of the data. Results are presented for all three resultant measures.

2.2.3 Controls

Our theory makes no predictions about which controls should be included in tests of the propositions that follow. Thus, we follow a "kitchen sink" approach. Although the controls are not theoretically motivated, they are useful in comparing the effect size of overconfidence on various independent variables to demographics.

The CCES provides many demographic 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 in each of the demographic controls. We also include a category for missing data for each variable. The controls, and number of categories they contain, can be found in Table 2.

3 Ideological Extremeness

The first set of theoretical and empirical results concern ideological extremeness.

[15] With one exception: the state of Virginia did not make their rolls available, so the 60 respondents from Virginia are dropped for turnout regressions. Classifying the 42 respondents that were found to have voted in the primary but not the general election as non-voters does not change the results.

Table 2: Controls used in statistical tests.

Type	Number of Categories
Income	16 categories
Education	6 categories
Gender	2 categories
Race	8 categories
Hispanic	3 categories
Religion	12 categories
Church attendance	8 categories
Union / union member in household	8 categories
State–including DC	52 categories
Total	**115 categories**

3.1 Ideological Extremeness

Define ideological extremeness as the ideological distance from the midpoint $\mathcal{E} = |\mathcal{I}|$. Our first prediction is that:

Proposition 1 *Ideological extremeness and overconfidence are correlated ($\rho_{\mathcal{E},\kappa} > 0$).*

Proof. All proofs can be found in the appendix. ■

A lemma is quite useful to understand the intuition behind this, and several other propositions. In particular, for those propositions which do not have an element of time, we can represent each citizen as having a single experience e_i. In particular, $e_i = x + \varepsilon_i$, where $\varepsilon_i \sim \mathcal{N}[0,1]$, $\forall i$. Despite the fact that every citizen's experience is an equally precise signal of the state of the world, citizens vary in how precise they *believe* their signals are. In particular, citizen i believes

$$\varepsilon_i \sim \mathcal{N}[0, \kappa_i].$$

If the believed precision $\kappa_i > 1$, then a citizen believes his information is more precise than it actually is, and, according to Definition 1 is overconfident.

Lemma 2 *For any n, $e_i = \frac{1}{n}\sum_{t=1}^{n} e_{it}$ and $\kappa_i = \frac{n}{1+(n-1)\rho_i}$.*

Using this lemma, the intuition underlying Proposition 1 is quite simple: consider two citizens with the same preference bias $b = 0$ and the same experience $e \geq 0$, but two different levels of overconfidence κ_1 and κ_2, with $\kappa_1 > \kappa_2$. The distribution of a citizen's beliefs after his or her experiences, will be distributed according to

$$\mathcal{N}\left[\frac{\kappa e_i}{\tau+\kappa}, \tau+\kappa\right]. \tag{2}$$

That is, after his or her experiences, each of our two citizens citizen will have ideology given by

$$\mathcal{I} = b_i + \mathbb{E}_i[x] = \frac{\kappa e}{\tau+\kappa} \qquad \text{and thus} \qquad \frac{d\mathcal{I}}{d\kappa} = \frac{\tau e}{(\tau+\kappa)^2} \geq 0. \tag{3}$$

That is, the more overconfident citizen is more ideologically extreme. Intuitively, the citizen that believes his experience is a better signal of the state of the world updates more on that signal, becoming more extreme. As each citizen is equally likely to get each signal, the distribution of ideology for more overconfident types will be more spread out.

This is illustrated in Figure 1. From the figure it is clear that as one moves further away from the ideological center, citizens are more likely to be more overconfident. Thus, ideological extremeness and overconfidence are correlated. The simplicity of the figure is driven in part 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 1 shows that there is still a positive correlation.

We can immediately test this proposition using survey data. In particular, Table 3 presents the results of regressing ideological extremeness, derived from the scaled ideology measure of Tausanovitch and Warshaw (2011), on our overconfidence measure.

Figure 1: Overconfidence and Ideological Extremeness are Correlated

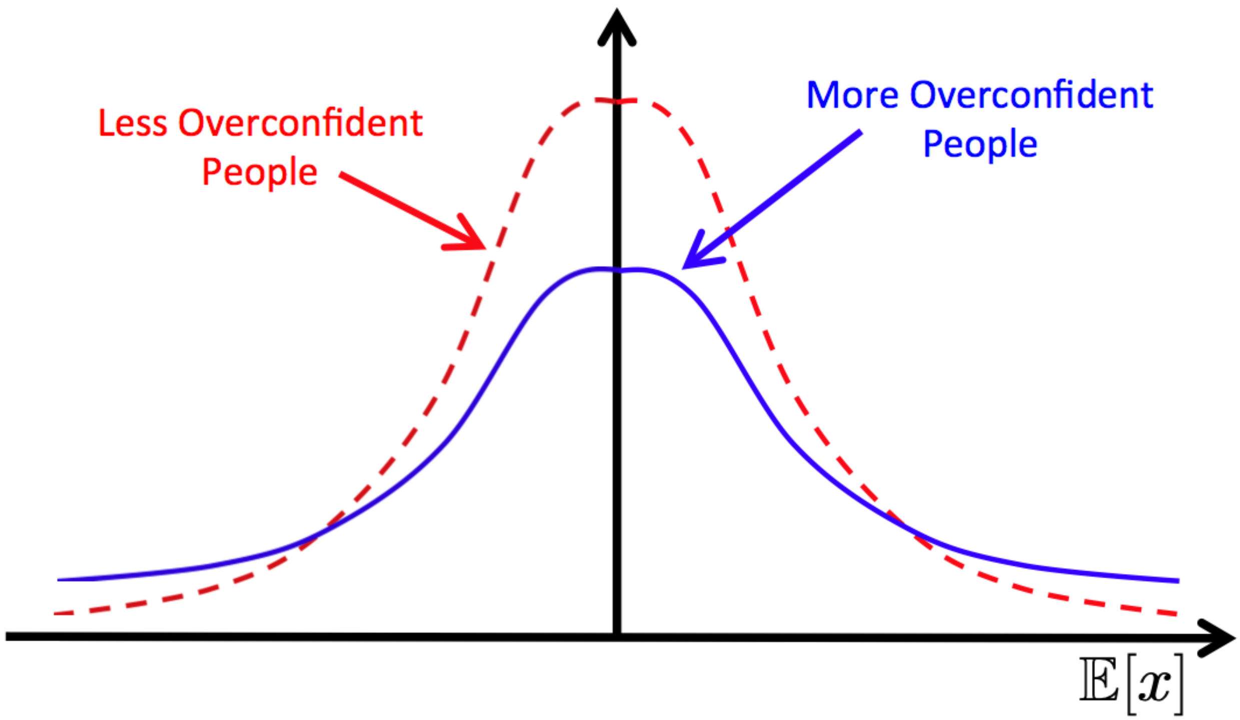


Table 3: Ideological extremeness is robustly related to overconfidence.

Dependent Variable: Scaled Ideological Extremeness					
Overconfidence	0.17*** (.019)	0.13*** (.018)	0.14*** (.019)	0.13*** (.019)	0.094*** (.018)
Income, Education Race, Hispanic		Y			
Union, Religion Church, State			Y		
Gender (Male)				0.28*** (.038)	
All Controls					Y
N			2,868		

Notes: ***, **, * denote statistical significance at the 1%, 5% and 10% level with standard errors in parenthesis.

Table 4: Self-reported ideological extremeness is robustly related to overconfidence.

Treatment of "Don't Know"	Centrist		Missing	
Overconfidence	0.12***	0.097***	0.11***	0.087***
	(.018)	(.019)	(.019)	(.020)
All Controls	N	Y	N	Y
N	2,910		2,754	

Notes: ***, **, * denote statistical significance at the 1%, 5% and 10% level with standard errors in parenthesis.

Two patterns are immediately apparent. First, the relationship between ideological extremeness and overconfidence is statistically robust, no matter what additional (non-theoretically motivated) controls are added to the regressions. Second, the control that leads to the greatest attenuation of the coefficient on over-confidence is gender, a factor that previous research (and Table 1) has found to be robustly correlated with overconfidence. In particular, a single control for gender attenuates the coefficient on overconfidence by approximately the same amount as the combined effect of including controls for income, education, race, and hispanic, or controls for union membership, religion, church attendance, and state of residence. This finding is reassuring: the control that really matters is the one found to be correlated overconfidence in other work.

In Table 4 we study similar relationships for self-reported ideology. As discussed in Section 2.2.2, there are two measures that depend on whether those that answered they "don't know" their ideological disposition are treated as centrist, or removed from the data. Table 4 considers both measures, and shows that the robust relationship found in Table 3 between ideological extremeness and overconfidence also exists in self-reported measures of ideology.[16]

[16]In Footnote 14 of Kuklinski et al. (2000) the authors note a strong correlation (0.34) between partisan strength and misinformation. Misinformation in that study is similar to confidence in incorrect opinions. This is the only similar empirical result we have found.

Table 5: Overconfidence is a substantively important predictor of ideological extremeness.

A one standard deviation change in ________ is associated	with a ________ standard deviation change in ideological extremeness. Minimum	Maximum
Income	13%	25%
Education	12%	20%
Race (Black)	12%	17%
Church attendance	7%	12%
Gender (Male)	6%	17%
Overconfidence	**9%**	**17%**

Notes: The minimum and maximum effect size come from regressions with no (other) control variables, and all other control variables respectively. In order to compute the effect size of categorical variables, such as education, they are entered linearly in the regressions.

One other pattern in Table 4 is worth noting: classifying those who report they don't know their ideological disposition as centrist increases the correlation between overconfidence and ideological extremeness. This appears intuitive: those that express a low level of confidence about their answer to factual questions are also likely to be relatively less confident about their ideological leanings.

While the relationship between ideological extremeness and overconfidence is clearly statistically robust, is it substantively important? Table 5 suggests the answer is yes. In particular, it asks how a one-standard-deviation change in a number of controls associates with a one-standard-deviation change in ideological extremeness. As the table shows, the effect size of overconfidence is similar in size to education, race, and gender; slightly smaller than income, and larger than church attendance.

3.2 Shifts in Average Ideology

While Proposition 1 holds for all values of the state of the world x, more nuanced predictions are possible by considering specific values of x. In particular, the following conjecture holds in simulations.

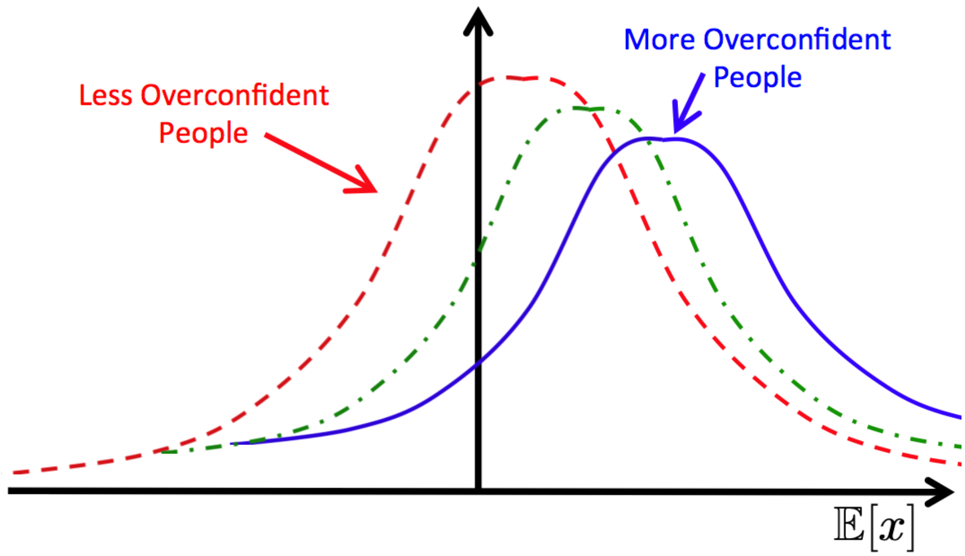
Conjecture 3 *If $\mathbb{E}[\mathbb{E}_i[\mathcal{I}]|\kappa]$ is increasing in κ, then ideological extremeness will be more correlated with overconfidence for those with ideologies to the right of median ideology than for those to the left.*[17]

The intuition for the conjecture is displayed in Figure 2(a). The figure is drawn using three different levels of κ to facilitate its comparison with the (smoothed) distribution of data from ideology self-reports, broken down by terciles of over-confidence, in Figure 2(b). To see the intuition behind the conjecture, start at the modal ideology of citizens with middling confidence—which is roughly median ideology. Moving right from this point, towards the mode of the most over-confident tercile, average overconfidence is strictly increasing along with ideological extremeness measured from the median point. Moving to the left, ideological extremeness measured from the median point is also increasing, but average overconfidence decreases initially. Eventually, average ideology will increase, but this occurs beyond the region of ideology that contains most citizens. Depending on which part dominates—the part close to the mode, or the part far away—the correlation to the left will be either small and negative or small and positive.

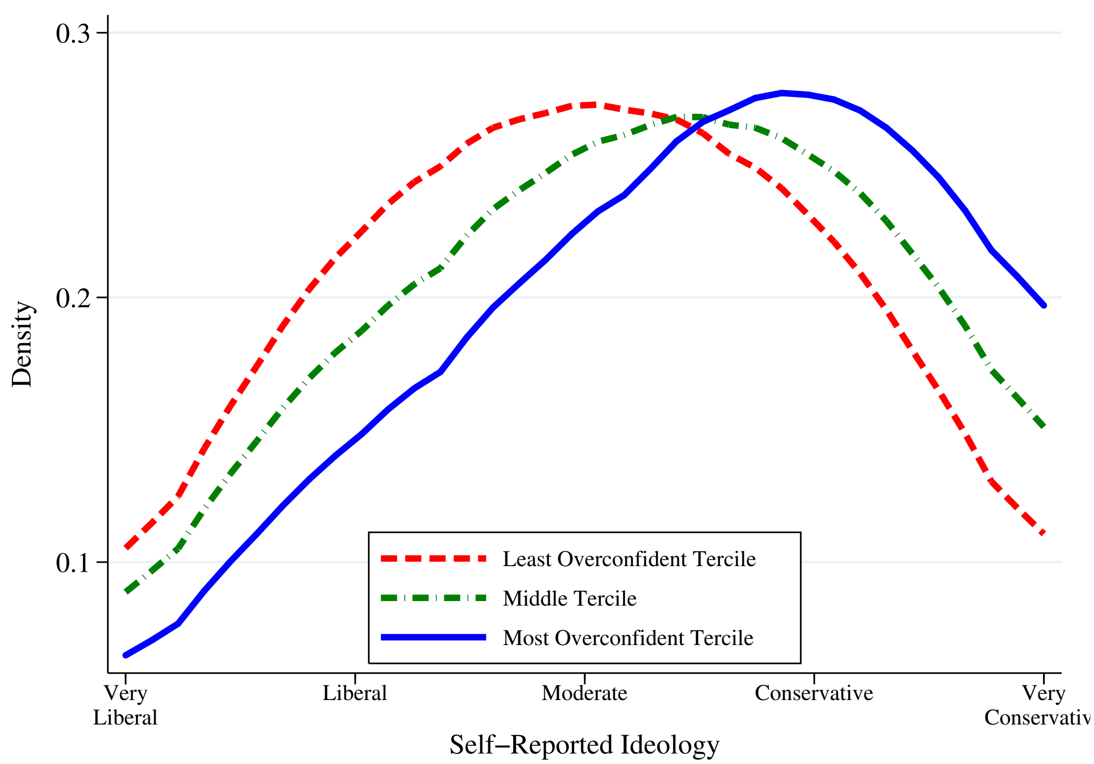
The similarity between Figure 2(a) and Figure 2(b) would lead one to believe that the conjecture holds.[18] A more rigorous analysis of the data requires that we first establish the hypothesis of the conjecture. Indeed, for all three measures of ideology, those in the middle and highest tercile of overconfidence are significantly further to the right than those in the lowest tercile. The difference between the first and second tercile (with standard error) for the scaled ideology measure is 0.31 (.045), and the difference between the first and third is 0.56 (.045). For the self-reported measure with "don't know" treated as ideologically centrist the corresponding differences are 0.29 (.045) and 0.49 (.045). When treating "don't know" as missing, the differences are 0.30 (.046) and 0.50 (.046). It is clear that for all three measures

[17]The hypothesis of the conjecture could be expressed as, "If $x > 0$ ...". However, as the zero point in the ideology scales in our data is arbitrary, this condition is not testable. Therefore we use a directly testable hypothesis for the conjecture.

[18]Scaled ideology produces a somewhat similar picture. However, as Tausanovitch and Warshaw (2011) use techniques to maximize discrimination in the tails, their estimates of ideology are strongly bimodal. While there are ways to make our theory generate bimodal distributions of ideology, we prefer to leave this for future work.



(a) Theory: When average ideology is increasing in overconfidence.



Note: Data is smoother using an Epanechnikov kernel function with bandwidth 0.8.

(b) Data: Distribution of self-reported ideology by tercile of overconfidence.

Figure 2: Theory and Data when more overconfident people are to the right ideologically.

Table 6: Overconfidence is more correlated with ideological extremeness for those right of center than those left of center.

Measure:	Scaled		Self-Reported Treatment of "Don't Know" Centrist		Self-Reported Treatment of "Don't Know" Missing	
	Left of Median	Right of Median	Left of Median	Right of Median	Left of Median	Right of Median
Partial Correlation with Overconfidence	-0.0025	0.15	-0.0099	0.14	-0.023	0.12
OLS Specifications						
Overconfidence	-0.014	0.18***	-0.022	0.15***	-0.056*	0.15***
	(.026)	(.026)	(.029)	(.025)	(.031)	(.025)
Difference	0.20***		0.18***		0.20***	
	(.037)		(.038)		(.040)	
All Controls	Y	Y	Y	Y	Y	Y
N	1,434	1,434	1,608	1,456	1,472	1,426

Notes: ***, **, * denote statistical significance at the 1%, 5% and 10% level with standard errors in parenthesis. The coefficient magnitudes in columns 1 and 2 can be compared to Table 3, and those in columns 3–6 can be compared to Table 4. The N of the two regressions may not sum to the N in those other tables due to the fact that those respondents with the median ideology are included in both regressions.

differences between the terciles are statistically significant.

As the hypothesis of the conjecture is clearly met for all three measures of ideology, Table 6 tests to see whether the conclusion is confirmed by the data. As is readily apparent from the table, ideological extremeness has a substantially higher correlation with overconfidence for those to the right of center than for those to the left of center.[19] We use the Frisch-Waugh-Lovell Theorem to compute partial correlations, after including all of the other controls. Because correlations have poor sampling properties, we then confirm the results,

[19] Another obvious prediction from Figure 2(a) is that the variance of ideology should be increasing in overconfidence. However, we cannot test this prediction because our data is ordinal, not cardinal. In Figure 2(b) this prediction does not appear to hold, however, there exists an affine transformation of the ideology measures, in particular one that reduces ideological differences in the center and increases them towards the sides, that would make the data appear to support this prediction.

and determine statistical significance, using OLS. For all three measures, overconfidence is statistically unrelated with ideological extremeness for those left of center.[20]

3.3 Historical Data

While the results in the previous subsection are perfectly compatible with our theory, they raise the concern that the correlation between overconfidence and ideological extremeness only exists for those that are right of center. While there is no way to refute this in the CCES data, more data across a greater range of contexts would be able to provide a greater understanding of the relationship between overconfidence and ideology.

Unfortunately, the 2010 CCES is the only survey we are aware of that provides both good measures of political ideology and of overconfidence. Thus, we instead turn to a survey with greater coverage over time, but has more limited measures of ideology, and only a proxies for overconfidence: the ANES. In particular, we follow a strategy based on the fact that many studies over time have found men to be more overconfident then women and use male as a proxy for "more overconfident".[21]

To begin the analysis we add a basic result.

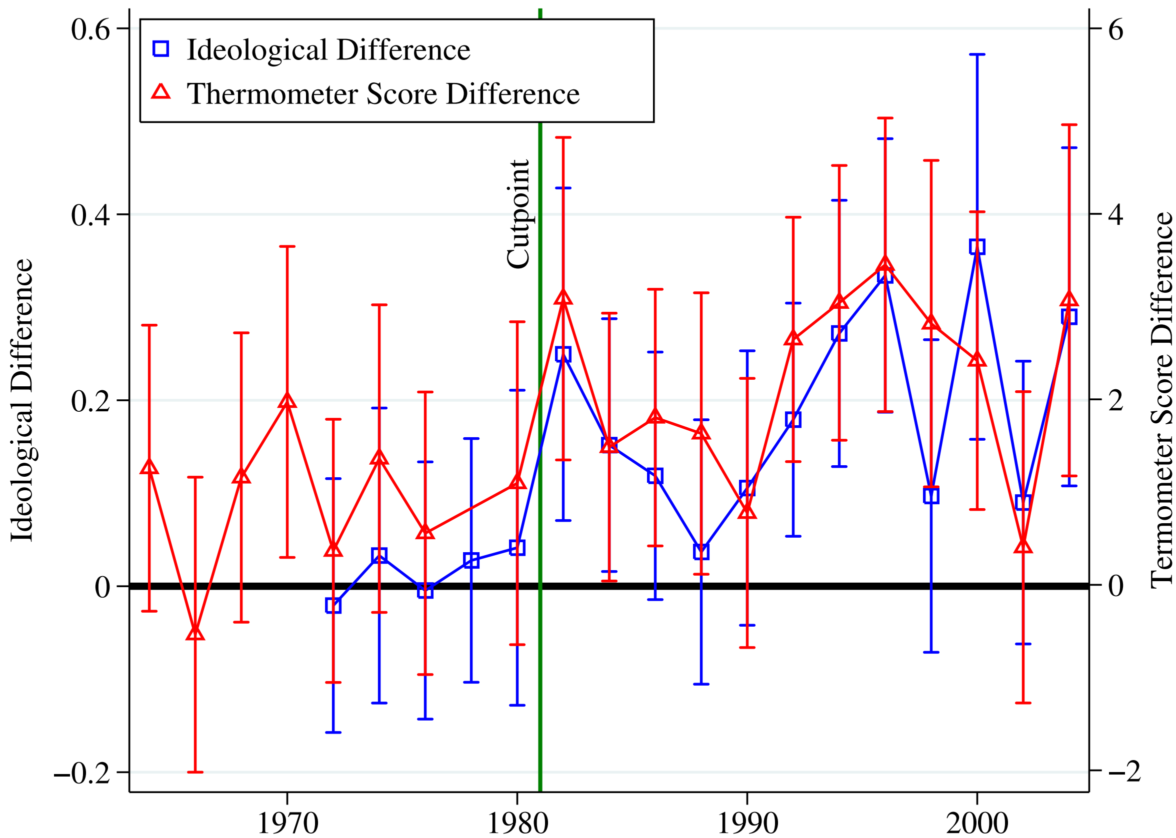
Proposition 4 *If more overconfident citizens have the same average ideology as less overconfident citizens, then overconfidence is equally correlated with ideological extremeness for both those to the right and to the left of center.*

Next, we investigate if there is variation over time in the difference between the average ideology of men and women. In particular, we have both self-reported ideology and the difference between respondent's thermometer scores for "liberals" and "conservatives", which is intended as a measure of ideology. Figure 3 plots the difference between men and women

[20] Ideological extremeness here is measured as the distance from median ideology in the overall population. Measuring ideological extremity from the nominal zero of the ideology scale does not qualitatively affect the results.

[21] Barber and Odean (2001) use male as an instrument for overconfidence in a study of financial risk taking. We have not adopted this strategy with the CCES data as being male is likely correlated with numerous other factors which may also affect the dependent variables we are interested in (Grinblatt and Keloharju, 2009). The curious reader may be interested to know that doing so approximately triples the effect size of overconfidence in the regressions presented in the previous, and subsequent, section.

Figure 3: Men became significantly more conservative after 1980.



Note: Thermometer scores were not collected in 1978.

on both of these scales over time with 95% confidence intervals in each year we have data. There is a clear rightward shift for men between 1980 and 1982. We divide the sample into two parts around 1981, and conduct a similar analysis to Table 6. The results can be found in Table 7.

The results in Table 7 are broadly consistent with the patterns predicted by Conjecture 3 and Proposition 4. For self-reported ideology, there is no statistical difference in average ideology between men and women before 1982, and, consistent with Proposition 4, men are equally more ideologically extreme, regardless of their ideological direction. After 1982, men are significantly further to the right then women on average, and, consistent with Conjecture 3, being male exhibits greater correlation with ideological extremeness for those to the right

Table 7: Data from the ANES is broadly consistent with Conjecture 3 and Proposition 4.

Time Frame	Up to 1980			1982 and After		
Dep. Variable	Ideology	Extremeness		Ideology	Extremeness	
Sample		Left of Median	Right of Median		Left of Median	Right of Median
Panel A: Self-Reported Ideology						
Male	0.013	0.14***	0.10***	0.18***	0.044**	0.16***
	(.032)	(.027)	(.025)	(.022)	(.019)	(.017)
Difference		0.035			0.11***	
		(.037)			(.025)	
Year Fixed Effects	Y	Y	Y	Y	Y	Y
N	6,880	4,241	5,132	15,183	8,808	11,395
Panel B: Thermometer Scores						
Male	0.88***	0.72***	1.62***	2.17***	-0.092	1.96***
	(.28)	(.24)	(.25)	(.23)	(.19)	(.21)
Difference		0.89**			2.05***	
		(.35)			(.28)	
Year Fixed Effects	Y	Y	Y	Y	Y	Y
N	11,439	6,551	8,709	18,105	10,455	12,992

Notes: ***, **, * denote statistical significance at the 1%, 5% and 10% level with standard errors in parenthesis. The N of the split-sample regressions do not sum to the N of the ideology regression due to the fact that those respondents with the median ideology are included in both regressions.

of the population median than for those to the left of the median.[22] For the thermometer scores, the difference in correlation between right and left expands as the ideological difference between men and women increases.

While the results presented in this section are broadly consistent with theory, further research is needed. In particular, gender is correlated with a multitude of political differences, and the shift in ideology that occurred in the 1980s has many potential explanations that

[22]The magnitudes of the coefficients are similar in magnitude to the coefficient on gender in the analysis of the 2010 CCES in Sections 3.1 and 3.2. After 1988, the self-reported ideological extremeness measure exhibits no statistically significant correlation with gender for those to the left of the median, which is consistent with the analysis in Table 6.

have nothing to do with overconfidence. We believe it is best to note that the available data is consistent with theory, but that better data is clearly needed.

3.4 Age

As noted in the introduction, and the previous section, the correlational neglect model allows us to make predictions about how age, overconfidence and ideology are related. In this subsection we extend the model to allow citizens to have differing amounts of experience: $e_{it} = x + \varepsilon_{it}$, $t \in \{1, 2, \ldots, n_i\}$, where we refer to $n_i \geq 2$ as citizen i's age.[23]

Proposition 5 *Older citizens are more overconfident, on average. Further, if $\rho \geq \frac{1+\rho_i\tau}{1+2\tau-\rho_i\tau}$ then ideological extremeness is increasing with age.*

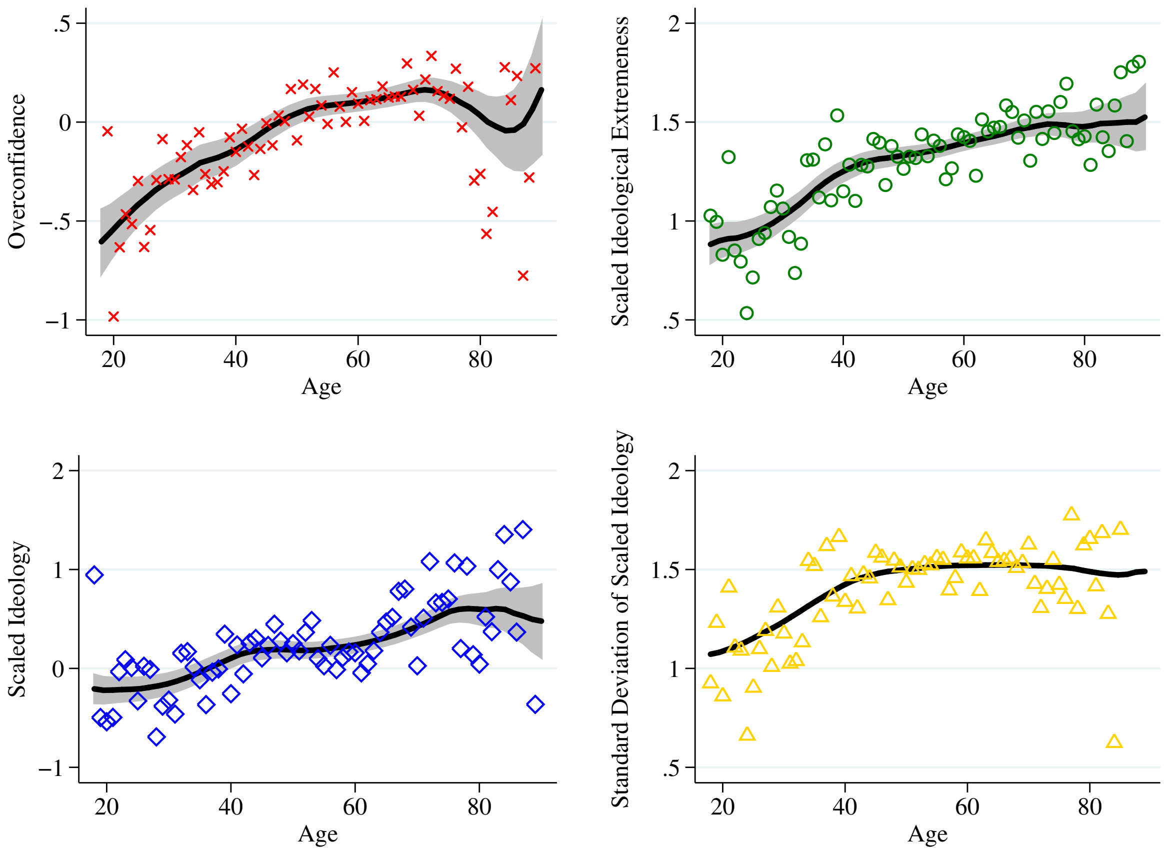
To build intuition, consider the case when $\rho_i = 0$ and $\rho = 1$, that is, when experiences are perfectly correlated, but citizen i believes that the signals are uncorrelated. By construction, as citizens age, they get more signals. In this case, each signal is identical, so it will make the citizen more confident, without increasing his information. Moreover, each signal makes a citizen more extreme, as his posterior shifts closer and closer to the signal. In general, the condition in Proposition 5 suggests that ideological extremeness will increase with age whenever the correlation between signals ρ is large, or, if the correlation is relatively small, when correlational neglect is large (ρ_i is small). This condition will be satisfied for natural values of the parameters: if $\tau = 1$, then the condition is satisfied as long as $\rho - \rho_i \geq \frac{1}{3}$ or ρ is close enough to one; and as τ grows large, the condition is always satisfied.

Figure 4 examines patterns in overconfidence and ideology by age. Each panel shows a smoothed, non-parametric, fit of the data, along with 95% confidence intervals, in addition to averages for each year of age. The first panel shows that, in accordance with Proposition 5, overconfidence increases with age, except for possibly among those who are older than 80, which is less than 1% of the data.[24] The second panel shows that ideological extremeness

[23] Empirically, we measure age in years, but theoretically, we only assume that the number of signals is weakly increasing over time, not that a citizen gets one signal per year.

[24] As overconfidence is a residual from a regression, about half the respondents have negative overconfidence scores. This should be interpreted as a respondent being less overconfident than average.

Figure 4: Age, Overconfidence, and Ideology



increases with age, consistent with our theory. The third and fourth panels show that this increase in ideological extremeness is due to both a slight rightward shift in ideology as people age, and an increase in ideological dispersion that levels out at about age 50. Interestingly, the increase in ideological extremeness is more pronounced than the rightward shift in ideology.

4 Turnout and Partisan Identification

To apply our analysis to other political behaviors, such as turnout and partisan identification, we must specify how citizens make political choices. To do so, we follow Matsusaka (1995) and Degan and Merlo (2011) in modifying the canonical model of voter turnout, due to Riker and Ordeshook (1968). In these models citizens will only vote if there is a high enough probability that one candidate or the other will give them higher utility once the state of the world is revealed—otherwise they will abstain. This could be linked the desire to avoid regret for having voted for the wrong candidate—motivated by the extensive findings that subjects feel regret for having made the wrong choice and take this into account when making a decision.[25] Or, as suggested by Degan and Merlo (2011), it could be simply linked to the tendency of decision makers to avoid making decisions whenever they are not sure of what is the correct answer—often referred to as *choice avoidance*.[26]

This modeling approach allows for both non-trivial turnout and strong partisan attachment even if the policies proposed by political parties are similar to each other, as seems to be the case (Snowberg, Wolfers and Zitzewitz, 2007*a*,*b*). In contrast, this is generally not possible in models that assume citizens turn out to vote only if the difference in expected utility of the platforms proposed is high enough (Riker and Ordeshook, 1968). To make this specific, suppose that both parties propose very similar platforms, and consider an agent who is quite sure that the best policy for her is the one proposed by party R. According to our definitions, this agent would strongly support, identify with, and turnout to vote, for party R. However, this would not hold if these behaviors were rooted in differences in expected utility: as the two parties suggest similar platforms, for any reasonably smooth utility function there is a small difference in utility between the two parties—and hence no reason to strongly identify with one party or the other, or turnout.

4.1 Formalization

[25]See, Connolly and Zeelenberg (2002), Zeelenberg (1999), Zeelenberg, Inman and Pieters (2001). Models of regret have then been frequently used to explain behavioral patterns which are not compatible with standard, expected-utility, models (Bell (1982), Loomes and Sugden (1982, 1987), Sugden (1993), and Sarver (2008)). Indeed, this piece of our model is a direct instantiation of Sugden (1993), applied to politics.

[26]Degan and Merlo (2011) note that as it is unlikely that a citizen will discover the true state of the world, they will not anticipate regretting their decision; instead, they discuss their model in terms of choice avoidance. For examples of choice avoidance in other contexts see Iyengar, Huberman and Jiang (2004), Iyengar and Lepper (2000), Boatwright and Nunes (2001), Shah and Wolford (2007), Schwartz (2004), Choi, Laibson and Madrian (2009), DellaVigna (2009), Reutskaja and Hogarth (2009), and Bertrand et al. (2010).

Partisan attachment and turnout will depend on the parties and their positions. We assume there are two parties that have committed to platforms L and R, with $L = -R$.[27] Denote $U_L(b_i|x)$ and $U_R(b_i|x)$ the utility that a citizen with bias b_i receives when the state of the world is x from the platform of parties L and R respectively.

First, we define the level of partisan attachment of a citizen. We assume that a citizen will be more likely to strongly associate when it is more likely, from the citizen's point of view, that a party has the correct policy—that is, the policy that would maximize the citizen's utility given some state of the world x. Formally, the level of partisan support for a citizen's favored party is given by

$$\left| \text{Prob}_i[U_L(b_i|x) > U_R(b_i|x)] - \frac{1}{2} \right|. \tag{4}$$

Second, to define turnout we begin with the canonical rational-choice model of voter turnout from Riker and Ordeshook (1968). A citizen turns out to vote if and only if

$$pB_i - C_i + D_i > 0 \tag{5}$$

where p is the probability an individual citizen's vote is pivotal, that is, changes the winner of the election, and B_i is the benefit, to the citizen of the citizen's favored candidate winning over the other candidate. The remaining terms C_i and D_i are the costs and benefits of voting that are unrelated to the outcome of the election.

Following the discussion above, we focus on these costs and benefits. In particular, we assume that there are idiosyncratic costs and benefits to voting, in addition to an idiosyncratic level of regret $\mathcal{R}_i$ if the citizen votes for a candidate whose platform turns out to be worse for the citizen, given the state of the world. That is

$$D_i - C_i = D_i - \mathcal{R}_i \mathbb{I}_{\text{vote=wrong}} - C_i'$$

[27] This divergence, symmetric about zero, can be generated from a Calvert (1985) type model with partially policy motivated parties, and our uncertainty about the position of the median voter generated by the random realization of x.

with D_i, R_i and C_i' i.i.d. draws from some (possibly different) distributions. We emphasize that (expected) regret can be seen as either a reduction in the benefit of voting, or an increase in the cost of voting.

This allows for a particularly convenient representation:

Lemma 6 *In large elections, comparative statics on voter turnout are the same as comparative statics on*

$$\left| Prob_i[U_R(b_i|x) > U_L(b_i|x)] - \frac{1}{2} \right| > c_i.^{28} \tag{6}$$

Note that c_i is an i.i.d. draw from some distribution F_c. For simplicity, we assume the c.d.f. F_c is strictly increasing on $\left(0, \frac{1}{2}\right)$.

The lemma shows that a citizen is more likely to turn out to vote if they believe that one party or the other is very likely to be correct, as this minimizes the chance that the voter will experience regret. Moreover, this lemma makes it clear that the comparative statics on partisan identification and on voter turnout will be identical.

4.2 Predictions

Our first theoretical result about turnout is empirically well documented:

Proposition 7 *More ideologically extreme citizens are more likely to turnout.*

It is interesting to note that this prediction does not depend on the specific form of the utility function, only on the fact that the utility function is single-peaked. This contrasts with the standard, pivot-probability, formulation which can produce this prediction only for very specific utility functions.

The intuition for this proposition is displayed in Figure 5(a). In this figure, we compare the probability of turning out for two citizens who have the same level of overconfidence κ,

[28] In large elections, the pivot probability will not matter, and thus turnout will be driven by the idiosyncratic costs and benefits of voting, including regret. In small elections the following propositions will hold for the quadratic loss utility function. In large elections the following results hold for any single-peaked utility function.

and the same preference bias $b = 0$. The probability that one or the other citizen turns out to vote depends on his or her belief about which candidate is more likely to be correct, which will depend on the citizens' posterior beliefs, which are distributed as in (2). In particular, we assume that citizen 1 has a more extreme belief than citizen 2: $\mathbb{E}_1[x] > \mathbb{E}_2[x]$, as in the figure, which implies that $e_1 > e_2$.

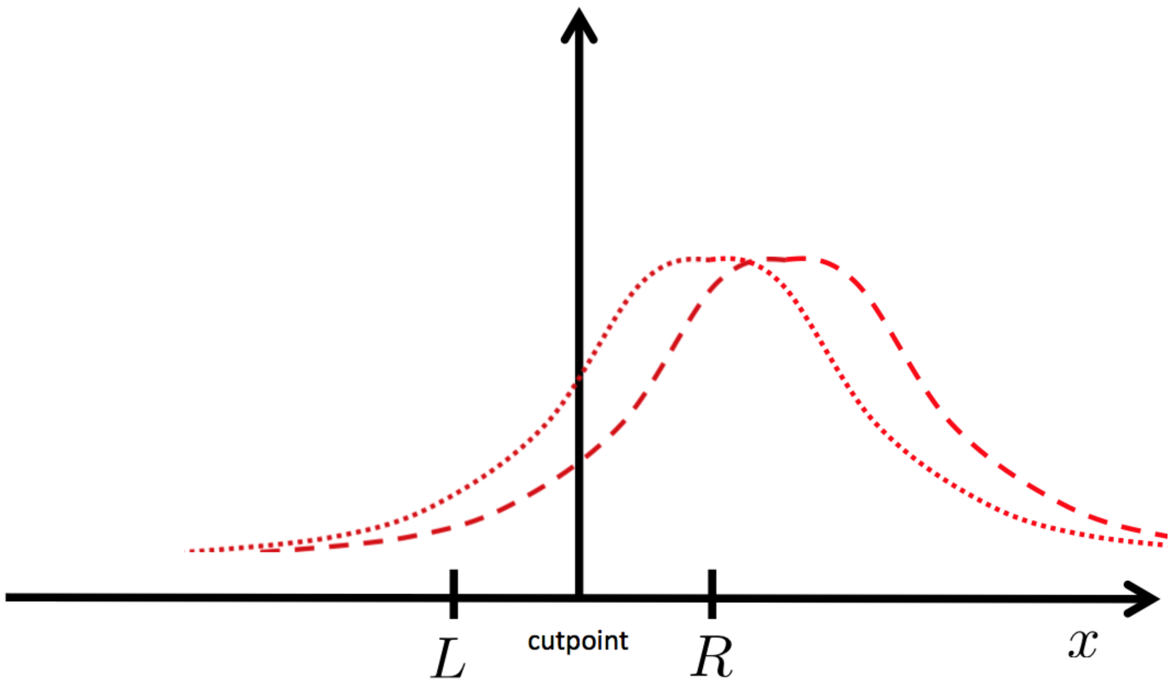
The positions of the parties L and R define a cutpoint, labeled in the figure at $x = 0$. If x is to the left of this cutpoint than party L is correct, whereas if x is to the right of this cutpoint than R is correct. It should be clear from the figure that citizen 1 puts a higher probability on R being right than citizen 2. Thus, citizen 1 is more likely to vote than citizen 2.

What then, is the role of overconfidence in turnout? Proposition 1 tells us that more overconfident citizens tend to be more ideologically extreme. Combining this with Proposition 7, this suggests that more overconfident citizens will be more likely to turn out. While this is indeed true in our model, the model makes an even stronger prediction: more overconfident citizens are more likely to turn out to vote even *conditional on ideology.*

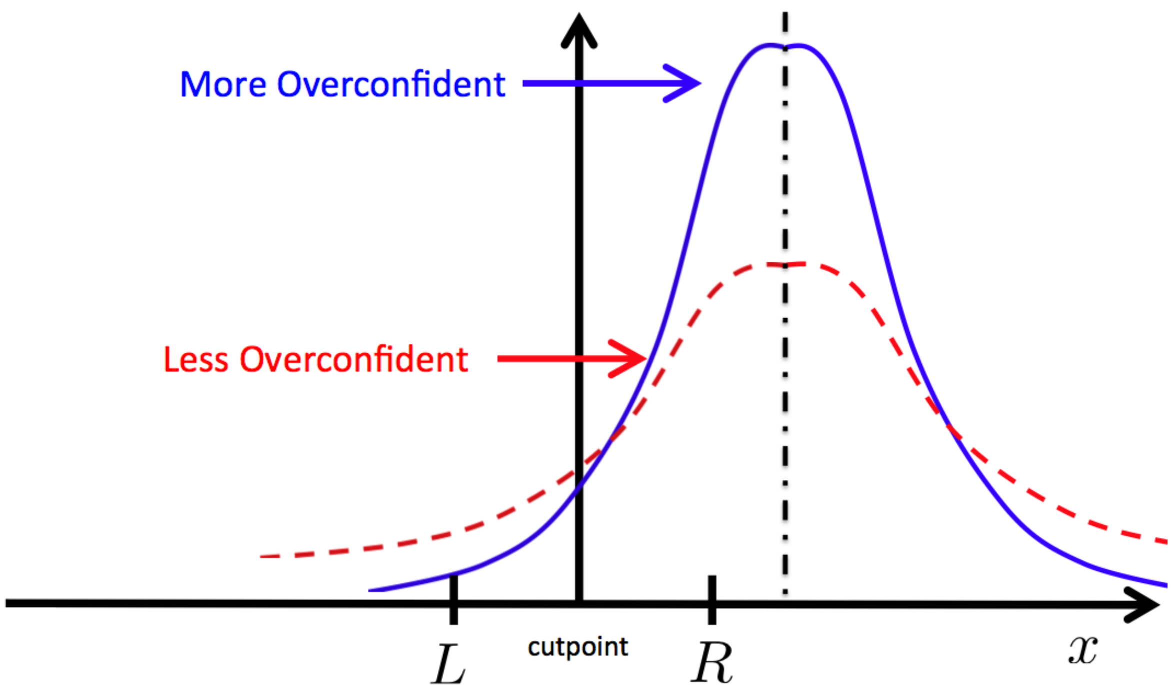
Proposition 8 *Conditional on ideology, more overconfident citizens are more likely to turn out to vote. Moreover, conditional on overconfidence, more ideologically extreme citizens are more likely to turn out to vote.*

The intuition behind the proposition is also shown in Figure 5. There, we consider two citizens, both with $b = 0$, and the same posterior mean belief $\mathbb{E}_i[x]$. However, citizen 1 is more overconfident than citizen 2, $\kappa_1 > \kappa_2$. Thus, according to (2), the posterior belief of citizen 1 is more precise, as shown in Figure 5(b). Applying the logic from the previous proposition, this implies that citizen 1 is more likely to think that party R is correct, and thus, more likely to turnout.

The last implication of the model we examine in survey data concerns the strength of partisan identification, as defined in (4).



(a) More ideologically extreme citizens are more likely to turnout.



(b) More overconfident citizens are more likely to turnout, conditional on ideology

Figure 5: Intuition for Propositions 7 through 9.

Proposition 9 *Strength of partisan attachment is increasing in overconfidence, both conditional on, and independent of, ideological extremeness. Moreover, conditional on overconfidence, strength of partisan attachment is increasing in ideological extremeness.*

Because of Lemma 6, the intuition for Proposition 9 is the same as that underlying Proposition 8.

4.3 Empirical Tests

We can test Propositions 7 and 8 using verified voter turnout from the 2010 CCES, as in Table 8. The results provide evidence in support of the propositions. Note that in Panel A, the control for gender is significantly associated with voter turnout. This occurs because the CCES is only approximately representative. In order to correct for known non-representativeness, the CCES provides sample weights. The results in Panel B use WLS and the sample weights. As can be seen, with the exception of the control for gender no longer being significant, the results are not much different.[29]

To get a full accounting of the the effect of overconfidence on turnout, we need to account for the fact that overconfidence is also associated with ideological extremeness. After doing so, a one-standard deviation increase in overconfidence is associated with a 4–14% increase in the probability that a respondent turns out to vote (a 2–7 percentage point increase versus a baseline turnout rate of 51% in the data). This effect is 34–41% (depending on the specification) of the effect size associated with ideological extremeness, which is known to be an important correlate of turnout.

To examine Proposition 9 in survey data we construct three measures of partisan attachment. All three code someone who identifies as a “Strong Democrat” or “Strong Republican” as a strong partisan, and most others as weak identifiers. As noted in Section 2.2.2, the three measures differ in how they treat those who identify as “Independent”. Although the theory does not ascribe any particular status to such people, it is possible that they are strongly invested in their identity as an independent. Therefore, the three different measures code

[29] The results in Tables 3 and 4 are slightly stronger when using the sample weights.

Table 8: Turnout is increasing in ideological extremeness and overconfidence, as predicted by Propositions 7 and 8.

Panel A: Unweighted						
Overconfidence	0.059***	0.035***	0.031***	0.028***	0.027***	0.019**
	(.0089)	(.0086)	(.0086)	(.0087)	(.0088)	(.0088)
Ideological Extremeness		0.15***	0.12***	0.14***	0.14***	0.12***
		(.0086)	(.0090)	(.0088)	(.0086)	(.0092)
Income, Education Race, Hispanic			Y			
Union, Religion Church, State				Y		
Gender (Male)					0.064***	
					(.018)	
All Controls						Y
N	2,808					

Panel B: Weighted						
Overconfidence	0.073***	0.042***	0.036***	0.034***	0.041***	0.026**
	(.014)	(.014)	(.014)	(.013)	(.014)	(.013)
Ideological Extremeness		0.18***	0.17***	0.17***	0.18***	0.16***
		(.013)	(.014)	(.013)	(.013)	(.013)
Income, Education Race, Hispanic			Y			
Union, Religion Church, State				Y		
Gender (Male)					0.019	
					(.029)	
All Controls						Y
N	2,808					

Notes: ***, **, * denote statistical significance at the 1%, 5% and 10% level with standard errors in parenthesis. All specifications in Panel A estimated using OLS. All specifications in Panel B estimated using WLS with CCES sampling weights as weights. The N of the split-sample regressions do not sum to the N of the ideology regression due to the fact that those respondents with the median ideology are included in both regressions.

Table 9: Overconfidence is correlated with strength of partisan identification, even controlling for ideological extremeness.

Treatment of Independents	Strong (1)		Weak (0)		Missing (.)	
Overconfidence	0.039***	0.038***	0.036***	0.032***	0.042***	0.040***
	(.093)	(.0098)	(.0093)	(.0094)	(.010)	(.010)
Ideological Extremeness		0.079***		0.13***		0.12***
		(.010)		(.0098)		(.011)
All Controls	N	Y	N	Y	N	Y
N	2,868				2,545	

Notes: ***, **, * denote statistical significance at the 1%, 5% and 10% level with standard errors in parenthesis.

independents as strong partisan identifiers (1), weak partisan identifiers (0), or drops these respondents all together. Table 9 then regresses these three measures on our overconfidence and ideological extremeness measures.

The results in Table 9 are consistent with theory, no matter which measure of strength of partisan identification is used. Doing the same accounting exercise as in Section 4.2, a one standard-deviation change in overconfidence is associated with a 6–8% increase in the probability a respondent classifies themselves a a strong party identifier (a 3–4 percentage point increase from a mean rate of strong party identification of 54%, 44% and 49%, respectively, for the three different measures). This effect is between 33–66% of the effect size associated with ideological extremeness.

One other pattern in Table 9 is worth noting: ideological extremeness is a better predictor of strength of partisan attachment when independents are treated as weak partisan identifiers, or left out of the data altogether. This makes intuitive sense: there are very few people who hold extremely conservative or liberal views, but identify as independent.

Note that Propositions 8 and 9 suggest that correlations between overconfidence and turnout and, and overconfidence and party ID should hold point-by-point, suggesting that perhaps ideological extremeness should be controlled for using fixed effects. While this is difficult with the continuous measure of ideological extremeness from Tausanovitch and Warshaw (2011), our other two measures are discrete. Entering these measures linearly, as fixed effects for a given value of ideological extremeness, or as fixed effects for a given value of ideology does not affect the results. Moreover, using these alternative measures of ideology strengthens the correlations between overconfidence and the dependent variables in Tables 8 and 9.

5 Conclusion

This paper examines some political implications of overconfidence. A novel model of overconfidence, designed for politics, is introduced. Implications for political behavior are drawn, and are tested in survey data. In particular, overconfidence is a substantively and statistically important correlate of such central political attributes as ideology, ideological extremeness, turnout, and strength of partisan attachment. The future work on this project will involve seeing how various institutional forms react with overconfidence to shape policy.

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Appendix A Survey Measures of Overconfidence

Ansolabehere, Meredith and Snowberg allowed us to append some questions to a survey they were running on the 2011 CCES (n =1,000). Like the 2010 CCES, this survey included questions on unemployment and inflation, as well as respondent confidence in their answers. These questions differed slightly in that the unemployment questions asked about changes in, rather than levels of, unemployment. There seems to have been some big differences in confidence across these two surveys: In 2010 on a scale of 1–6, the average level of confidence about current inflation was 3.3, and confidence about future inflation was 3.45, whereas in 2011 the means were 2.5 and 2.45, respectively. Perhaps this was due to the fact that 2011 was not an election year in most places. Regardless, we use these questions to construct a measure of overconfidence using the same procedure detailed in this paper.

In addition, we asked four factual questions. These concerned the year the telephone was invented, the population of Spain, the year Shakespeare was born, and the percent of the US population that lives in California. These questions were all examples given in previous research on overconfidence.

We followed these questions with the same six point assessment of the respondent's confidence discussed in the text, and a question designed to elicit a confidence interval. However, rather than asking for a confidence interval directly, which we felt may have been too challenging for survey respondents, we asked them to give their estimates of the probability that the true answer was in some interval around their answer. So, for example, after giving their best guess as to the date of Shakespeare's birth, respondents were asked:

> What do you think the percent chance is that your best guess, entered above, is within 50 years of the actual answer?

Given a two-parameter distribution, such as a normal, this is enough to pin down the variance of a respondent's belief.

Mean confidence (on a six point scale) on our four questions was 2.3, 1.85, 2.0 and 2.1, respectively. On the 100 point (percent) scale, mean confidence was 71, 46, 48, and 43 respectively. Both the six point and 100 point scales of confidence were used to construct overconfidence indices, using the same method as before. Finally, all 12 confidence questions together were used to construct a combined index of overconfidence. This allows for controlling for many more dimensions of factual knowledge. Thus, we have four measures of overconfidence: economy, trivia (6 point), trivia (100 point), and combined. The economy measure, which is closest to the measure used in this paper, is correlated with the trivia (6 point) measure at 0.51, the trivia (100 point) measure at 0.28, and the combined measure at 0.61. All four measures are robustly correlated with gender.

The 2011 CCES contains only self-reported ideology. The four measures correlate with self-reported ideological extremeness: economy at 0.12, trivia (6 point) at 0.06, trivia (100 point) at 0.10, and combined at 0.10. Using OLS, these correlations are significant at greater than 1% in all cases but trivia (6 point), which is significant at the 5% level. The relevant comparison for 2010 is a correlation of 0.12, which is comparable to the economy measure in 2011.

One might worry that the variation in the trivia (6 point) and trivia (100 point) overconfidence measure that is correlated with ideological is different than the variation in economy overconfidence measure that is correlated with ideological extremeness. To examine this concern we instrument the economy measure with these two measures. The coefficient size is the same when instrumenting with trivia (6 point) and triples in magnitude when instrumenting with trivia (100 point) indicating that the same variation in all three scores is correlated with ideological extremeness.

While these results are not as robust due to the smaller sample size, and there are some differences between election and non-election years, it does appear that traditional ways of measuring overconfidence produce similar correlations to those observed in the body of this paper.

Appendix B Proofs

Proposition 1 *Ideological extremeness and overconfidence are correlated ($\rho_{\mathcal{E},\kappa} > 0$).*

Lemma 2 *For any n, $e_i = \frac{1}{n}\sum_{t=1}^{n} e_{it}$ and $\kappa_i = \frac{n}{1+(n-1)\rho_i}$.*

Proof of Lemma 2: The posterior likelihood in the model is proportional to

$$
\begin{aligned}
\mathcal{L}(x|e_i) &\propto \mathcal{L}(e_i|x)\mathcal{L}_0(x) \\
&\propto \exp\left\{-\frac{1}{2}\begin{pmatrix} x-e_{i1} \\ x-e_{i2} \\ \vdots \\ x-e_{in_i}\end{pmatrix}^T \begin{pmatrix} 1 & \rho_i & \cdots & \rho_i \\ \rho_i & 1 & \cdots & \rho_i \\ \vdots & \vdots & \ddots & \vdots \\ \rho_i & \rho_i & \cdots & 1 \end{pmatrix} \begin{pmatrix} x-e_{i1} \\ x-e_{i2} \\ \vdots \\ x-e_{in_i}\end{pmatrix}\right\} \exp\left\{-\frac{1}{2}x^2\tau\right\} \\
&= \exp\left\{-\frac{1}{2}\left(\frac{nx^2 - 2x\sum_{t=1}^{n_i} e_{it}}{1+(n_i-1)\rho_i} + C\right)\right\} \exp\left\{-\frac{1}{2}x^2\tau\right\} \\
&\propto \exp\left\{-\frac{1}{2}\frac{n_i+\tau(1+(n_i-1)\rho_i)}{1+(n_i-1)\rho_i}\left(x - \frac{\sum_{t=1}^{n_i} e_{it}}{n+\tau(1+(n_i-1)\rho_i)}\right)^2\right\}
\end{aligned}
$$

where C is constant with respect to x. Thus, defining $e_i = \frac{1}{n_i}\sum_{t=1}^{n_i} e_{it}$, the posterior belief of a citizen is distributed according to

$$
\mathcal{N}\left[\frac{n_i e_i}{n_i+\tau(1+(n_i-1)\rho_i)}, \frac{n_i+\tau(1+(n_i-1)\rho_i)}{1+(n_i-1)\rho_i}\right].
$$

Substituting $\rho_i = \frac{n_i-\kappa}{(n_i-1)\kappa}$ the posterior is given by

$$
\mathcal{N}\left[\frac{\kappa e_i}{\kappa+\tau}, \kappa+\tau\right],
$$

as in (2). ∎

Proof of Proposition 1: First, to use the lemma, note that $\mathbb{E}[e_i] = x$, and

$$\begin{aligned} \mathrm{Var}[e_i] &= \left(\frac{1}{n}\right)^2 \sum_{t=1}^{n} \mathrm{Var}[\varepsilon_{it}] + 2\left(\frac{1}{n}\right)^2 \frac{n(n-1)}{2} \mathrm{Cov}[\varepsilon_{it_1}, \varepsilon_{it_2}] \\ &= \frac{1}{n} + \frac{n-1}{n}\rho. \end{aligned}$$

Thus, $e_i \sim \mathcal{N}\left[x, \frac{n}{1+(n-1)\rho}\right]$. For simplicity, and without loss of generality, we normalize $\rho = 1$ so that $e_i \sim \mathcal{N}[x, 1]$, as in the text.

The distribution of beliefs is given by

$$\begin{aligned} \mathrm{Prob}((\mathbb{E}_i[x]|\kappa) < y) = \mathrm{Prob}\left(\frac{\kappa(x+\varepsilon)}{\tau+\kappa} + \pi < y\right) &= \mathrm{Prob}\left(\varepsilon < \frac{\tau+\kappa}{\kappa}\left(y - \pi - \frac{\kappa x}{\tau+\kappa}\right)\right) \\ &= \Phi\left[\frac{\tau+\kappa}{\kappa}\left(y - \pi - \frac{\kappa x}{\tau+\kappa}\right)\right] \\ \Rightarrow \quad \mathbb{E}_i[x]|\kappa &\sim \mathcal{N}\left[\frac{\kappa x}{\tau+\kappa}, \left(\frac{\tau+\kappa}{\kappa}\right)^2\right], \end{aligned} \tag{7}$$

where $\Phi[\cdot]$ denotes the c.d.f. of the standard normal distribution.

$\rho_{\mathcal{E},\kappa} > 0$ when $\mathrm{Cov}[\mathcal{E}, \kappa] > 0$. The definition of covariance and the law of iterated expectations gives

$$\begin{aligned} \mathrm{Cov}[\mathcal{E}, \kappa] &= \mathbb{E}[\mathcal{E} \times \kappa] - \mathbb{E}[\mathcal{E}]\mathbb{E}[\kappa] \\ &= \mathbb{E}[\mathbb{E}[\mathcal{E} \times \kappa|\kappa]] - \mathbb{E}[\mathbb{E}[\mathcal{E}|\kappa]]\mathbb{E}[\kappa] \\ &= \mathbb{E}[\kappa \times \mathbb{E}[\mathcal{E}|\kappa]] - \mathbb{E}[\mathbb{E}[\mathcal{E}|\kappa]]\mathbb{E}[\kappa] = \mathrm{Cov}[\mathbb{E}[\mathcal{E}|\kappa], \kappa] \end{aligned}$$

Note that $\mathcal{I}_i|\kappa = b_i + \mathbb{E}_i[x|\kappa]$ is a sum of two independent random normal variables. This implies that the distribution, conditional on κ, of ideology is also a normal random variable with mean given by the sum of means of the two variables, and variance given by the sum of variances of those two random variables. Thus,

$$\mathcal{I}|\kappa \sim \mathcal{N}\left[\frac{\kappa x}{\tau+\kappa}, \frac{\tau_b(\tau+\kappa)^2}{\tau_b\kappa^2+(\tau+\kappa)^2}\right] \tag{8}$$

$$\text{and,} \quad \frac{d}{d\kappa}\left(\frac{\tau_b\kappa^2+(\tau+\kappa)^2}{\tau_b(\tau+\kappa)^2}\right) = \frac{2\kappa\tau}{(\kappa+\tau)^3} > 0 \tag{9}$$

Note that, according to (8), $\mathcal{I}|\kappa$ is distributed according to a normal distribution, and $\mathcal{E} = |\mathcal{I}|$, so $\mathcal{E}|\kappa$ is distributed as a folded normal. When $y \sim \mathcal{N}\left[\mu, \frac{1}{\sigma^2}\right]$, then

$$\mathbb{E}[|y|] = 2\sigma\,\phi\left[\frac{\mu}{\sigma}\right] + \mu\left(1 - 2\Phi\left[-\frac{\mu}{\sigma}\right]\right)$$

where ϕ is the standard normal p.d.f. Assume $\mu \geq 0$, then

$$\frac{d}{d\mu}\mathbb{E}[|y|] = 1 - 2\Phi\left[-\frac{\mu}{\sigma}\right] \geq 0$$
$$\frac{d}{d\sigma}\mathbb{E}[|y|] = 2\phi\left[\frac{\mu}{\sigma}\right] > 0$$

$\mu \geq 0$ implies $x \geq 0$. Taken together with the fact, shown in (3), that the mean $\mathcal{I}|\kappa$ is weakly increasing in κ, and the variance, as shown in (9), is increasing in κ, this implies that $\mathbb{E}[\mathcal{E}|\kappa]$ is increasing in κ. A symmetric argument establishes this fact when $\mu, x < 0$. Using the result in Schmidt (2003), this implies $\mathrm{Cov}[\mathbb{E}[\mathcal{E}|\kappa], \kappa] > 0$, and thus $\rho_{\mathcal{E},\kappa} > 0$. ■

Proposition 4 *If more and less overconfident citizens have the same average ideology, then overconfidence is equally correlated with ideological extremeness for both those to the right and to the left of center.*

Proof of Proposition 4: Consider two citizens with $\kappa_1 > \kappa_2$. As $\mathbb{E}[\mathbb{E}_i[\mathcal{I}|\kappa]] = \frac{\kappa x}{\tau+\kappa}$, we have that $\frac{\kappa_1 x}{\tau+\kappa_1} = \frac{\kappa_2 x}{\tau+\kappa_2} \Rightarrow x = 0$. Thus,

$$\mathcal{I}|\kappa \sim \mathcal{N}\left[0, \frac{\tau_b(\tau+\kappa)^2}{\tau_b\kappa^2+(\tau+\kappa)^2}\right].$$

As this is symmetric about zero for all κ, it implies $\text{Cov}[\mathbb{E}[\mathcal{E}|\kappa, \mathcal{I} \geq 0], \kappa] = \text{Cov}[\mathbb{E}[\mathcal{E}|\kappa, \mathcal{I} \leq 0], \kappa]$ and $\text{Var}[\mathcal{I}|\mathcal{I} \geq 0] = \text{Var}[\mathcal{I}|\mathcal{I} \leq 0]$. Finally, as this implies $f(\kappa|\mathcal{I} \geq 0) = f(\kappa|\mathcal{I} \leq 0) = f(\kappa)$, thus, $\text{Var}[\kappa|\mathcal{I} \geq 0] = \text{Var}[\kappa|\mathcal{I} \leq 0]$. Taken together this implies $\rho_{\mathcal{E},\kappa|\mathcal{I}\geq 0} = \rho_{\mathcal{E},\kappa|\mathcal{I}\leq 0}$. ■

Proposition 5 *Older citizens are more overconfident, on average. Further, if* $\rho \geq \frac{1+\rho_i\tau}{1+2\tau-\rho_i\tau}$ *then ideological extremeness is increasing with age.*

Proof of Proposition 5: For a given ρ_i, a citizens' overconfidence after n_i signals is given by:

$$\frac{n_i + \tau(1 + (n_i - 1)\rho_i)}{1 + (n_i - 1)\rho_i} - \frac{n_i + \tau(1 + (n_i - 1)\rho)}{1 + (n_i - 1)\rho} > 0 \iff \rho_i < \rho$$

The difference in overconfidence between the citizen at age $n_i + 1$ and age n_i is given by

$$\frac{n_i(\rho - \rho_i)(2 + (n_i - 1)(\rho + \rho_i - \rho\rho_i)}{(1 + (n_i - 1)\rho_i)(1 + n_i\rho_i)(1 + (n_i - 1)\rho)(1 + n\rho)} > 0$$

because $0 < \rho_i < \rho < 1$ and $n_i \geq 2$. When $\rho_i < \rho$, the increase in a citizens posterior precision will be in excess of the new information transmitted, so older citizens will be more over-confident.

To establish the second part, consider a citizen who observes n_i signals e_{it} who believes that the correlation between those signals is ρ_i. Following Lemma 2 define $e_i = \dfrac{1}{n_i}\displaystyle\sum_{t=1}^{n_i} e_{it}$, and his mean belief is $\frac{n_i e_i}{n_i+\tau(1+(n_i-1)\rho_i)}$. In turn, e_i is distributed according to $e_i \sim \mathcal{N}\left[x, \frac{n_i}{1+(n_i-1)\rho}\right]$. This means that his mean belief is distributed according to a normal distribution with mean $\frac{n_i x}{n_i+\tau(1+(n_i-1)\rho_i)} = 0$ and variance $\frac{1+(n_i-1)\rho}{n_i} \cdot \frac{n_i^2}{(n_i+\tau(1+(n_i-1)\rho_i))^2}$.

Following the proof of Proposition 1 it suffices to show that the variance of the ideology of agents who receive $n + 1$ signals is higher than the variance of the ideology of agents who receive n. That is, we need to show

$$\frac{1 + n\rho}{n + 1} \cdot \frac{(n + 1)^2}{(n + 1 + \tau(1 + n\rho_i))^2} - \frac{1 + (n - 1)\rho}{n} \cdot \frac{n^2}{(n + \tau(1 + (n - 1)\rho_i))^2} \geq 0 \qquad (10)$$

We will argue that the LHS increasing in ρ. We first show that the derivative of the LHS with respect to ρ is positive, that is

$$n(1+n)(n+(1+(n-1)\rho_i)\tau)^2 - (n-1)n(1+n+(1+n\rho_i)\tau)^2 \geq 0$$

which, in turn, is equal to

$$n + n^2 + 2n\tau + 2n^2\tau + 2n\tau^2 - 2n\rho_i\tau^2 + 2n^2\rho_i\tau^2 + n\rho_i^2\tau^2 - n^2\rho_i^2\tau^2 \geq 0.$$

Since $\rho_i \in [0,1)$, $n \geq 1$, and $\tau > 0$, then we must have $2n\tau^2 - 2n\rho_i\tau^2 \geq 0$ and $2n^2\rho_i\tau^2 - n^2\rho_i^2\tau^2 \geq 0$, which implies that that the condition is satisfied.

Since this the LHS of Equation 10 increasing in ρ, and a since we know $\rho \geq \frac{1+\rho_i\tau}{1+2\tau-\rho_i\tau}$, then it suffices to show that this condition holds when $\rho = \frac{1+\rho_i\tau}{1+2\tau-\rho_i\tau}$. Replacing ρ with this value and solving yields

$$\frac{(\rho_i-1)^2\tau^2(1+2n+(2+(2n-1)\rho_i)\tau)}{1+(2-\rho_i)\tau} \geq 0,$$

which is always true since $\rho_i \in [0,1)$, $n \geq 1$, and $\tau > 0$. ■

Lemma 6 *In large elections, comparative statics on voter turnout are the same as comparative statics on*

$$\left| Prob_i[U_R(b_i|x) > U_L(b_i|x)] - \frac{1}{2} \right| > c_i.$$

Proof of Lemma 6: When elections are large $p \to 0$ in (5). Supposing citizen i favors candidate R if he or she were to vote, citizen i will vote if and only if

$$\begin{aligned}
D_i - \mathcal{R}_i \mathbb{E}[\mathbb{I}_{\text{vote=wrong}}] - C_i' &> 0 \\
\text{Prob}[\text{vote} = \text{wrong}] &< \frac{D_i - C_i'}{\mathcal{R}_i} \\
1 - \text{Prob}[U_R(b_i|x) > U_L(b_i|x)] &< \frac{D_i - C_i'}{\mathcal{R}_i} \\
\text{Prob}[U_R(b_i|x) > U_L(b_i|x)] - \frac{1}{2} &> \frac{1}{2} - \frac{D_i - C_i'}{\mathcal{R}_i} = c_i.
\end{aligned}$$

The absolute value follows from symmetry of considering the case where i favors candidate L. ■

Proposition 7 *More ideologically extreme citizens are more likely to turnout.*

Proposition 8 *Conditional on ideology, more overconfident citizens are more likely to turn out to vote. Moreover, conditional on overconfidence, more ideologically extreme citizens are more likely to turn out to vote.*

Proposition 9 *Strength of partisan attachment is increasing in overconfidence, both conditional on, and independent of, ideological extremeness. Moreover, conditional on overconfidence, strength of partisan attachment is increasing in ideological extremeness.*

Proof of Propositions 7, 8, 9: Consider an individual i with ideology $\mathcal{I}$, overconfidence κ, and preference bias b. Suppose, without loss of generality that $\mathcal{I} > 0$. Notice first that we have $\mathbb{E}[x] = \mathcal{I} - b$. This means that we have $U_R(b|x) > U_L(b|x)$ if and only if $x > -b$. In turn, this means that we have $\text{Prob}_i[U_R(b_i|x) > U_L(b_i|x)] = \text{Prob}_i[x > -b] = 1 - \text{Prob}_i[x < -b]$. By construction this is equal to $1 - \Phi\left[(-b - (\mathcal{I} - b))\sqrt{\tau + \kappa}\right] = \Phi\left[\mathcal{I}\sqrt{\tau + \kappa}\right]$.

Now notice that, assuming $\mathcal{I} > 0$, $\mathcal{I}\sqrt{\tau + \kappa}$ must be strictly increasing in κ conditional on $\mathcal{I}$, and in $\mathcal{I}$ conditional on κ. The same must therefore hold for $\Phi\left[\mathcal{I}\sqrt{\tau + \kappa}\right]$, and hence for $\text{Prob}_i[U_R(b_i|x) > U_L(b_i|x)]$ and (4). Note that specular results would hold conditional on $\mathcal{I} < 0$. This means that we can replace $\mathcal{I}$ with $\mathcal{E} = |\mathcal{I}|$, and obtain the same results, proving Proposition 9.

To prove Proposition 8, note that $F_c(\cdot)$ is a c.d.f. and thus increasing in its argument. Proposition 8 and Proposition 1 together give Proposition 7. ■