

Cognitive Biases in Governing: Technology Preferences in Election Administration

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MS 226-823, *Public Administration Review*

Abstract

Cognitive biases are heuristics that shape individual preferences and decisions in a way at odds with means-end rationality. The effects of cognitive biases on governing are underexplored. We study how election administrators' cognitive biases shape their preferences for e-voting technology using data from a national survey of local election officials. The Technology Acceptance Model, which employs a rational, means-end perspective, suggests that the perceived benefits of e-voting machines explain their popularity. But our findings indicate that cognitive biases also play a role, even after controlling for perceived benefits and costs of the technology. The findings point to a novel cognitive bias that is of particular interest to research on e-government: officials who have a general faith in technology are attracted to more innovative alternatives. We also find that local election officials who prefer e-voting machines do so in part because they overvalue the technology they already possess, and because they are overly confident in their own judgment.

INTRODUCTION

Classical models of rationality, championed by the discipline of economics, remain the most enduring basis for understanding decision-making. The rational actor model has frequently been criticized, but increasingly such attacks have come from within economics itself, from the sub-field of behavioral economics. Drawing strongly from psychology, behavioral economics points out that people are imperfectly rational and often rely on heuristics to make decisions, especially under conditions of ambiguity. These shortcuts may help to manage complexity, but also introduce systematic errors known as cognitive biases (Keil, Depledge and Rai 2007). There has been limited effort to understand the implications of cognitive biases for the preferences, decisions, and actions of public actors. One exception is the study of how individuals make systematic error in crisis settings (Stern 1997). But cognitive biases are not necessarily limited to contexts of stress. For example, Krause (2006) reveals cognitive biases in the routine business of public sector macroeconomic forecasting.

In this article we explore how cognitive biases shape technology preferences. This is an important question because technology has become a key means by which governments seek to foster improved quality and efficiency. But quite often the potential of new technologies depends upon the preferences of individual administrators. To take a contemporary example, the Health Information Technology for Economic and Clinical Health Act, included in the economic recovery package of the American Recovery and Reinvestment Act of 2009, devoted \$36 billion to foster the creation and sharing of electronic healthcare records. But this investment, and its impact on health services more broadly, depends largely on the willingness of health care providers to adopt and use new technology. Although this particular policy is unusually salient and expansive, it resembles many such reforms regularly contemplated and implemented at all

levels of government to address all types of public issues. While the adoption of new information technology is a central theme of contemporary governance, new technologies have a spotty record of performance (Garson 2006; Goldfinch 2007).

We consider the impact of cognitive biases on technology preferences in the policy area of election administration. Specifically, we explore whether or not local election officials are more likely to prefer Direct Recording Electronic (DRE) (also known as e-voting) machines over alternative voting systems because they believe in technological innovations (which we call *faith in technology bias*), overvalue technology they already possess (*status quo bias*), discount information that challenges their existing preferences (*confirmation bias*), and are overly confident in their own judgment (*own judgment bias*). Our conceptualization of faith in technology as a cognitive bias is new, and of particular relevance to research on e-government.

More generally, our study addresses a research gap and offers a number of advantages over existing research. The growing attention to election administration after the 2000 presidential election prompted a wave of research (e.g., see PAR symposium volume 68, issue 4), yet this scholarship largely overlooks the preferences of the local officials who actually administer elections and does not consider the potential role of cognitive biases in technology selection. In addition, while empirical evidence of cognitive bias comes largely from experimental settings, we examine the surveyed preferences of public officials and therefore provide a needed empirical contribution to research on technology adoption. Finally, our data enable us to control for a number of factors that should account for rival explanations. Most notably, we are able to control for the perceived benefits and costs of voting systems, as suggested by the well-established Technology Acceptance Model (TAM) (Davis 1989).

In the sections that follow, we provide some background on DRE voting systems and the politics of election administration; discuss the cognitive biases that are the focus of this study and present hypotheses concerning how these biases should affect preferences toward DREs; review our data and methodology; and discuss the results of our statistical tests.

POLICY BACKGROUND

In this section we provide a brief review of DRE machines and the politics of election administration. The decision-making environment for local election officials is one characterized by disagreement and ambiguity, and therefore provides a good setting to test for the presence of cognitive biases.

Direct Recording Electronic Machines

DRE machines are an ATM-like version of the ballot box, providing a computer interface through which voters select their choices from lists of candidates on a screen. One of the most emphasized benefits of this format is that it offers advantages for voters with disabilities. The 2002 Help America Vote Act (HAVA) required that each election jurisdiction adopt at least one DRE machine in order to facilitate voting for the disabled.

Even as HAVA was passed concerns arose about the security and reliability of DREs. Computer security specialists pointed out that DRE machines employ complex software and that software of any complexity is susceptible to tampering by hackers and likely to have internal errors. Moreover, DRE software is proprietary, so the general public and local election officials had little sense of its complexity or how it worked. Concerns increased as reports emerged about unusual election results associated with DREs (GAO 2005, 31; Commission on Federal Election

Reform 2005, 25). Compounding these problems was the fact that DREs operated without some form of redundancy that would allow them to recover from failure, and that they did not produce an independent verification of the vote tabulation.

Researchers from CalTech and MIT (2001a) argued that election officials should adopt optical scan systems, noting their greater reliability and lower costs. In 2005 the Government Accountability Office (GAO) issued a report critical of the use of DREs, noting “significant concerns about the security and reliability of electronic voting systems, citing instances of weak security controls, system design flaws, inadequate system version control, inadequate security testing, incorrect system configuration, poor security management, and vague or incomplete standards, among other issues” (GAO 2005, 22-23). Many state governments acknowledged the problems posed by DREs and required that they be equipped with a printer that produces a paper ballot that can provide a check against the internal DRE tabulation (Electionline 2008), and the bipartisan Carter-Baker Commission on Federal Election Reform also recommended that DREs be fitted with paper printers.

Not all assessments of DREs have been negative. While some research found that DREs are less effective than optical scan systems in terms of limiting residual votes (CalTech and MIT 2001b; Ansolabehere and Stewart 2005) – i.e., unmarked, spoiled, or uncounted ballots – later research suggested that newer DREs are better designed and less likely to yield residual votes than other voting systems (Stewart 2006). In addition, DREs scored well in terms of their usability. Much of the appeal of DREs rested on their greater capacity to meet the needs of voters with disabilities and those who are not native English speakers. Laboratory research, field studies, and public opinion surveys have revealed that members of the public are comfortable using DREs, find them easy to use, and are relatively confident in their accuracy (Herrnson,

Niemi, Hanmer, Francia, Bederson, Conrad, and Traugott 2008; Alvarez, Hall, and Llewellyn 2008). Some also have suggested that the security issues with DREs were overstated, unrealistic, or at least no worse than those of other important technologies (Shamos 2006).

The Politics of Voting Systems

The aftermath of the troubled 2000 presidential election in Florida opened a policy window in election administration (Montjoy 2005). A conventional interpretation of events is that problems arose at least in part because of antiquated election technology, and that election administration would improve with the introduction of more modern systems. By passing HAVA in 2002 the federal government offered financial incentives to replace older voting systems with newer ones. Punch-card ballots, paper ballots, and lever machines were on the way out, to be replaced by either DREs or optical scan machines.¹

The sudden salience of election administration and the political pressure to adopt new voting systems made for an uncertain policymaking environment. The relative costs and benefits of DRE and optical machines were not well understood, but public officials were quick to adopt them in the aftermath of HAVA. Fifty-four percent of jurisdictions reported using electronic systems for the 2006 election, while 43 percent used optical scans (US EAC 2007). Such quick adoption likely compounded the uncertainty surrounding DREs, as rapid policy change reduces the opportunity to accumulate performance knowledge of competing options (Montjoy 2008, 792).

Local Election Officials and DREs

Recent policy changes in election administration increased the role of state governments, but local officials still play an important role in election policy design and implementation. Such officials make up a significant portion of the federal Election Assistance Commission's advisory commissions and state-appointed planning committees (Alvarez and Hall 2005). Over 70 percent of the officials we surveyed report having the power to purchase voting systems. Local officials also enjoy significant discretion in elections administration generally (Kimball and Kropf 2006; Moynihan and Silva 2008), and this discretion has been associated with significant variation across localities in the adoption and implementation of election administration procedures (Alvarez and Hall 2008; Hite 2007, 29-46), as well as outcomes, such as the occurrence of provisional and residual votes (Ansolabehere and Stewart 2005, 386; Kimball, Kropf, and Battles 2006).

The central role of these local officials in election administration placed them squarely in the uncertain decision-making environment we describe above. The sudden salience of election administration thrust upon them rapid policy changes and heightened the stakes of their decisions. While the relative costs and benefits of optical scan machines and the technologically more sophisticated DRE machines were unclear, these officials were pushed into establishing preferences regarding these technologies and, often times, adopt one or the other. In such a context, local election officials' relative preferences for DRE machines should have been influenced by cognitive biases. For example, in their review of a finding that officials were generally content with their voting technologies, researchers at the GAO concluded that "this satisfaction was based mostly on the subjective impressions of election officials rather than on objective data that measured voting system performance" (Hite 2007, 50). In the following section, we discuss the different types of biases that might influence officials' preferences.

Cognitive Bias and Technology Preferences

We draw primarily on insights from cognitive dissonance theory (Festinger 1957) and prospect theory (Kahneman and Tversky 1979) to motivate our hypotheses about cognitive bias. According to dissonance theory, people seek consistency between their beliefs and behavior. When dissonance exists between the two, they seek to eliminate it by changing their behavior or by changing their beliefs. One strategy individuals might employ is to reduce the emphasis they place on dissonant beliefs or evidence, or to seek more consonant beliefs or evidence to outweigh the dissonant ones.

Prospect theory has shown that the framing of options affects preferences and decisions. Kahneman and Tversky (1979) illustrate the power of decision frames through a series of experiments. They show that when options are framed in terms of prospective losses, rather than potential gains, decision-makers tend to become more cautious, even though the underlying risk of the option remains unchanged. The research agenda that arose from prospect theory looks beyond loss aversion to focus broadly on influential decision frames: “the decision-maker’s conception of the acts, outcomes and contingencies associated with a particular choice” (Kahneman and Tversky 1981, 453).

“Faith in Technology” Bias

Faith in technology can operate as a psychological frame through which public officials view policy problems and solutions. Research suggests that those who have faith in technology are more likely to prefer the most technologically advanced options for public services. Moon and Welch (2005) find that relative to the general public, public officials are more supportive of

e-government implementation, more confident in the ability of information technology to provide public services, and less worried about security and privacy issues raised by technology.

A generalized faith in technology gives e-government the normative characteristics of a faith-based movement, deflecting reasoned analysis in favor of a predetermined course of action. This tendency has been frequently observed among public officials, and the way in which it is described – as a utopian technological determinism (Garson 2006), cyberoptimism (Norris 2001), or idolization (Goldfinch 2007) – certainly implies that a form of cognitive bias exists.

DRE machines are the most technologically advanced option among election systems. Faith in technology has been proposed as an explanation for the popularity of DREs (Moynihan 2004), and has been associated with positive evaluations of the federal legislation that promotes DREs (Moynihan and Silva 2008). Thus, we offer the following hypothesis:

Hypothesis 1: Election officials who possess a general faith in technology are more likely to rate DREs highly relative to other systems.

Status Quo Bias

A status quo bias occurs when “individuals have a strong tendency to remain at the status quo, because the disadvantages of leaving it loom larger than advantages” (Kahneman, Knetsch and Thaler 1991, 197-198). Samuelson and Zeckhauser (1988) offer evidence of the status quo bias. In an experiment where individuals were presented with a range of investment options, designating one as the status quo (as a portfolio they had inherited) always made it more popular. Closely related to status quo bias are endowment effects, where individuals who have been given or purchased goods tend to overvalue those goods relative to market information about their value (Kahneman, Knetsch and Thaler 1991).

Individuals might also develop emotional attachments to previous decisions. For instance, individuals are likely to hold onto losing stocks rather than sell them at a loss (Sherfin and Statman 1985). The attachment to previous decisions may be driven by a fear of regret and a need to justify previous behavior. According to cognitive dissonance theory, individuals might react to post-decision dissonance by adjusting their beliefs. Particularly relevant to this study, Keil, Mann, and Rai (2000) find that self-justifying behavior helps to explain escalating commitment to troubled information technology projects.

The purchase of new voting systems is the most substantial investment that an election official makes, and these systems tend to stay in place for considerable periods because of the significant costs of switching. If the voting system is criticized, election officials may deal with feelings of dissonance by defending the status quo. Attachment to the current system is likely to be strongest among those who actually created the status quo, that is, the election officials who have purchasing responsibility. Thus, we offer the following hypothesis:

Hypothesis 2: Officials whose jurisdictions employ DREs as their main voting systems are more likely to rate DREs highly relative to other systems—especially if they possess the power to purchase their jurisdiction’s election systems.

Confirmation Bias

When reversing initial positions is difficult, cognitive dissonance theory suggests that people will tend to seek information that supports their behavior and discount critical information. This tendency towards confirmation bias is sufficiently prevalent for Nickerson (1998, 175) to state “If one were to attempt to identify a single problematic aspect of human reasoning that deserves attention above all others, the *confirmation bias* would have to be among the candidates for consideration.” Tuchman (1984, 245) has argued that confirmation bias in

governance can best be seen in the rationalization of previous policy decisions: “Once a policy has been adopted and implemented, all subsequent activity becomes an effort to justify it.” Such a selective perception of information also has been associated with an escalation of commitment to technologies (Keil, Depledge and Rai 2007).

As we note above, local election officials continue to be influential in the adoption of voting systems and bear much of the responsibility for their performance, and they have witnessed a growing tide of criticism of DREs from online activists, computer security specialists, and the mainstream media. In order to avoid dissonance, election officials who think highly of DREs are likely to discount this criticism as uninformed and irrelevant, and this confirmation bias should be greater among those who already employ DREs as a main voting system. Thus, we offer the following hypothesis:

Hypothesis 3: Election officials who employ DREs as their main voting system are more likely to discount criticism of DREs—especially if they possess the power to purchase their jurisdiction’s election systems.

“Own Judgment” Bias

Another aspect of confirmation bias is overconfidence in one’s own judgment (Nickerson 1998), also described as “the illusion of validity” (Kahneman and Tversky 1973) or “the illusion of control” (Langer 1975). As individuals come to know more about a topic, they become surer of their assessments, even when additional knowledge does not help decisions and may even prompt poorer outcomes (Tetlock 2005). Individuals come to regard positive outcomes as the natural result of their skills and assume a confidence in their future success that is unrelated to evidence or probability.

At the time the survey was administered, the true costs and benefits of DREs relative to those of optical scan machines were highly contested and opaque, and differences between older and newer DREs further complicated assessments of their performance. Compounding this ambiguity is the fact that local election officials do not have good objective data on the performance of voting systems (Hite 2007). Users of DREs may be able to report that their machines did not fail in any obvious way, but they cannot tell for sure that DREs recorded the votes accurately. So, while election officials might have successfully operated DREs on Election Day, they likely lack significant knowledge about the costs and benefits of DREs. Indeed, even experienced managers dealing with tested technologies tend to be poor predictors of possible difficulties (Goldfinch 2007). Local election officials who indicate confidence in their level of knowledge about DREs are likely overconfident about their understanding of the benefits of DREs. Thus, we offer the following hypothesis:

Hypothesis 4: Election officials who express confidence in their knowledge of DREs are likely to express preferences for DREs that are out of proportion with the benefits of DREs that they report.

DATA AND METHOD

The data come from a survey of local election officials administered between November 29, 2004 and February 14, 2005. We selected 3,779 officials to contact from a database of all (approximately 9,300) local election officials in the United States, which is maintained by the Election Reform Information Project. The contact information was verified by a team of graduate students who contacted each jurisdiction selected for the sample. There is great variation in the number of election officials per state, much of which is related to the

decentralization of election administration in some states, as opposed to variation in state populations. To reduce the dominance of states with large numbers of election officials, we split the states into categories of large (more than 150 officials) and small (fewer than 150 officials). We surveyed all officials in small states and 150 randomly sampled officials in large states.

Of the 3,779 officials sampled, we contacted via email the 3,151 officials for whom we could find email addresses and requested that they fill out an online survey. In order to ensure that there is not a digital divide among respondents, those who did not respond to emails, or for whom we could not find email addresses, were sent a paper version of the survey. The overall response rate was 40.2 percent.²

One of the reasons that so much of the evidence on the role of cognitive bias is limited to experimental settings is that it is difficult to ask individuals direct questions about bias and expect an accurate response. Individuals are likely to deny that their decision-making incorporates non-rational heuristics because it is socially undesirable to do so, or simply because they are unaware of their biases. To avoid such problems, the survey questions do not directly ask individuals whether they hold biases. Instead, they inquire about a status or belief that can be reasonably associated with a cognitive bias. For example, rather than asking local election officials if they are overconfident in their evaluation of DREs, we ask them a number of questions about their level of understanding of an opaque and proprietary technology.

Variables

The main variables used in the analysis are described below. A more detailed description of the survey questions used to construct our variables are provided in the appendix, along with descriptive statistics and Cronbach's alpha for indexes.

Dependent Variables. The main dependent variable (*preference for DREs*) measures how favorably a local election official rates DRE machines relative to technologically less-sophisticated voting systems. It is a continuous variable created by accounting for how positively a respondent feels about DREs and subtracting from this total their average response to this question for all other possible voting systems. A higher value of this variable indicates more positive feelings toward DREs. A second dependent variable (*critical media*) is used to test the confirmation bias hypothesis that respondents who own DREs are more likely to find that the media is overly critical of DREs. Specifically, the variable captures how strongly a respondent agrees with the statement that the media is too critical using an ordinal scale that goes from one (strongly disagree) to seven (strongly agree).

Predictor Variables. The key predictor variables we employ to test our hypotheses include an index that captures the level of faith in technology (*faith in technology bias*), a variable that indicates if a DRE is the status quo system in place (*status quo bias*), and a variable (*DRE rating*) that captures how highly an official rates DREs, which is meant as a control in our test of the hypothesis regarding media criticism. The variable *own judgment bias* is an interaction of *confidence in DRE knowledge* and *benefits* (variables which we discuss below). This variable helps us determine if the impact of perceived benefits of DREs on officials' reported preference for DREs is magnified when a local official is confident in his or her own knowledge of DREs.

Cost-Benefit Controls. An important control variable that we include captures the benefits of DREs. A popular and intuitive approach to explaining the adoption and use of new technology is the Technology Acceptance Model (TAM). This is a rational actor model that predicts that technologies are adopted and used when their usefulness and ease of use are perceived to be higher than those of the status quo technology (Davis 1989; Norris and Moon 2005).

The variable *benefits* is an index that captures how reliable, secure, accurate, and easy to use a local election official perceives DREs to be, weighted by how important the official deems those attributes to be. In addition, we include a variable *low cost*, which is an index that summarizes how low officials perceive the acquisition and maintenance costs of DREs to be.

Controlling for Trust in DRE Technology. Another particularly important control variable, and one which is related to the cost-benefit variables above, captures what we call “trust” in DRE technology. Because we wish to assess the impact of respondents’ general faith in technology, it is important that we tease out how respondents feel about DRE technology in particular. While DREs have been criticized as having many risks, most of these have to do with perceived weaknesses in their software (GAO 2005). We therefore control for the level of trust in DRE software, as election officials who trust this software are more likely to prefer DREs or to perceive that the media are overly critical of DREs. Specifically, we constructed a variable, *trust DRE technology*, which is an index of items that inquire about officials’ perceptions regarding how vulnerable DRE machines are to tampering and to viruses and other malicious software. The scales of these items were reversed, so that higher values indicate greater trust.

Controlling for Influence and Professionalism. We include a number of controls to capture how professionalized and influential the respondent is. These include the power to purchase equipment (*purchasing power*), how much influence over system adoption the official reports (*adoption influence*), if the official is elected (*elected*), the number of hours per week worked on election administration (*hours per week*), the official’s salary (*salary*), and the number of years the official has served in his or her current position as a local election official (*years of experience*).

Controlling for Information. Agency theory points to the role of information differentials and conflicting incentives in principal-agent relationships. Local election officials purchase their voting machines from vendors. Because of the economics of voting systems (high fixed costs and infrequent use), the purchase of new systems is rare, and many officials had never purchased voting systems prior to the passage of HAVA. These basic conditions – a principal with little information seeking to purchase a product from an agent with expertise – gives rise to the classic principal-agent problem, and its severity should be greater in the case of opaque DRE technology. Vendors promoting DREs may be able to win the confidence of officials and sell them a product that they might not have purchased if they had a perfect understanding of the technology and its alternatives (Caltech-MIT 2001a, 53; Moynihan 2004, 521). And local election officials dependent on vendors for information likely have a more favorable view of DREs due to the selective information they receive from vendors. Our model therefore controls for the degree to which respondents indicate being dependent on vendors for information about voting systems (*reliance on vendors*). Additionally, we include a variable that captures how much confidence an official has in her or his own knowledge of DREs (*confidence in DRE knowledge*)—a measure which also comes to bear through an interaction term mentioned above.

Demographic Controls. We also account for the age (*age*), sex (*female*), and level of education (*education*) that officials reported.

Statistical Methodology

We report the results of models estimated using Ordinary Least Squares regression. We do so for the models that employ the continuous *preference for DREs* variable, as well as the model that employs the ordinal *critical media* variable, in order to facilitate presentation and

interpretation. The latter has seven categories and appears to capture a normal underlying distribution (albeit with some truncation on the right-hand side) and estimating the model using ordered logit yields similar results. To ensure that we are not underestimating our standard errors due to some unobserved state-level effects, we report standard errors that are clustered by state. In addition, to avoid extensive case-wise deletion as a result of numerous missing values—due in large part to our creation of indexes—we present the results of models estimated using data for which missing values were imputed.³

The statistical results are robust to various statistical techniques and model specifications. Limiting models to cases without missing values yields results similar to those we report. Likewise, we obtained similar results when models were estimated without controls or with state-level fixed effects,⁴ as well as when separate models were estimated for elected and non-elected officials. It should be noted that the inclusion of state-level fixed effects had some effect on the coefficient, and weakened the statistical significance, of the predictor *currently uses DRE*, which we use to estimate status quo bias.⁵

We also estimated models with sampling weights so that the results are representative of the population of local election officials and to account for the impact that officials have on the general population. In the first case, we estimated the probability that a local election official was sampled (which was simply equal to one if he or she resided in a state with fewer than 150 officials) and took the reciprocal to create the weights. In the second case, we adjusted the previous weight to account for the proportion of the total general population that officials serve and the proportion of local election officials that operate in each state. The inclusion of weights does not change the substantive significance of the results, but the inclusion of the second type of weight moderates the impact and significance of the *status quo bias* variable. Since the primary

focus of the research is on the population of election officials, and not the general population, we do not present the results of models estimated using sampling weights, but we discuss the impact of weighting below if it had some effect on our findings.

RESULTS

Table 1 summarizes the results of the five models we estimated in order to test the four hypotheses we list above. The first model is meant as an explicit test of whether “faith in technology” bias and status quo bias explain local election officials’ preference for DRE machines over other voting systems—as per hypothesis 1 and hypothesis 2. Consistent with our hypotheses, we find that local officials who report having a general faith in technology and who report using DREs as their main voting system also report a greater preference for DREs as compared to other voting systems. The results are particularly striking given the range of controls, including the perceived benefits of and trust in DREs, which were also significant.

[Insert Table 1 about here.]

Hypothesis 2 also suggests that officials with the power to purchase voting systems are more likely to rationalize their decisions and therefore express a preference for DREs if their jurisdictions have adopted DREs as a main voting system. Models 3 and 4, which estimate separate regressions for officials with and without purchasing authority, yield results that are consistent with this hypothesis. Specifically, it appears that the impact of the variable *status quo bias* is greater and more statistically significant for those officials with purchasing power—although both coefficients are significant at $p=0.05$ for a one-tailed test and the difference between the coefficients does not quite reach traditional levels of statistical significance. Overall, the findings suggest the importance of the status quo bias in technology preferences,

even after we control for the respondent's evaluation of the costs and benefits of a technology. In alternative specifications where we employed state-level fixed effects and one type of population sampling weight, the size and significance of the *status quo bias* coefficients was reduced and sometimes eliminated. Nevertheless, our results generally indicate that status quo bias affects the preferences of local election officials, and these results hold even when models are limited to officials who are not responsible for purchasing equipment.

Although we focus on bias toward DRE systems, it is worth emphasizing that officials appear to possess some status quo bias for whatever technology their jurisdictions possess. For example, DRE users on average rated DREs 6.54 on a scale from 1 (strongly oppose) to 7 (strongly support) in response to "How do you feel about the use of the following types of voting systems for elections in the United States?", but they rated central and precinct count optical scan systems 4.38 and 3.93, respectively. On the same scale, optical scan users rated DREs 4.38 on average, while rating central and precinct count optical scans 5.65 and 6.22, respectively. There may be some selection bias at work, as officials are more likely to have adopted technologies they prefer (although, as we discuss in endnote five, selection bias should be minimal).

Model 2 tests if confidence in one's own judgment makes one more likely to prefer DREs. Specifically, hypothesis 4 suggests that the impact of *benefits* on *preference for DREs* should be magnified for officials who report confidence in their knowledge of DREs. The positive and statistically significant impact of *own judgment bias* supports this hypothesis. The results indicate that officials' preferences for DREs are related to the benefits of DREs that they perceive only if their confidence about their own knowledge is sufficiently high. The results might be interpreted as being consistent with a rational cost-benefit model if officials could accurately gauge their knowledge, since the variable would then simply capture risk aversion.

But we argue that high confidence in one's knowledge of DREs is illusory because of the opaque nature of the technology, and because the benefits and risks of DREs were poorly understood and contested by experts at the time the survey was administered. If one agrees with our assessment, then this result provides empirical support of "own judgment" bias.

Model 5 provides a test of hypothesis 3, which states that officials who have DREs as their main voting system are more likely to perceive the media as being overly critical of DREs. In this model we also include *DRE rating*, which is meant to control for how positively officials feel about DRE machines—a variable which, unsurprisingly, yields a positive and statistically significant coefficient, and provides for a very stringent test of the hypothesis. Contrary to our hypothesis, the coefficient for *DRE* is not statistically significant (although the coefficient has the correct sign). This result obtains whether an official has purchasing power or not.

Overall, the findings provide empirical support for hypotheses that proposed that various cognitive biases – faith in technology, an attachment to the status quo, overconfidence in one's own judgment – affect technology preferences. The *faith in technology bias* variable is consistently significant (at the $p=0.05$ level for a one-tailed test) even in model 5, in which we control for officials' attitudes toward DREs in addition to other controls. Second, *benefits* is statistically significant across the models (via *own judgment bias* in model 2), which provides strong support for the TAM model—especially in light of the number and type of statistical controls we include. Although we do not wish to say much about the multitude of controls we included, it is probably worth pointing out that officials' years of experience is often negatively related to preferences for DREs even when one controls for age and a number of other professional and demographic factors.

CONCLUSION

Understanding the preferences that drive officials' decision-making is crucial to our understanding of governance. In the policy area of election administration we find that theories of cognitive bias help explain public officials' preferences for e-voting technology. Specifically, our results indicate that local election officials who prefer Direct Recording Electronic machines over alternative voting systems do so in part because they have faith in technological innovations, overvalue the technology they already possess, and are perhaps overly confident in their own judgment. On the other hand, we do not find clear evidence that DRE users are more likely to find the media to be overly critical, which would have provided evidence of confirmation bias; and the results that are consistent with status quo bias may be driven in part by the fact that those who adopt DREs are those who prefer them in the first place. Overall, however, our results provide strong evidence that technology preferences are shaped by cognitive biases.

One source of strength in our analysis is that we control for local election officials' beliefs about the benefits and costs of DRE machines, as well as trust in those machines. In other words, in our statistical models we make the conservative assumption that bias can be detected even after controlling for these factors. That we find robust statistical evidence of bias in spite of the inclusion of these and other controls is striking, suggesting that our analysis might in fact underestimate the impact of bias that may be captured by these control measures.

Another source of strength in our analysis is that it enables us to engage the Technology Acceptance Model. Research suggests that some local election officials are overly confident in their expertise, and we show that the benefits of DREs that officials perceive are correlated with their preferences for DREs if their confidence about their DRE-related knowledge is sufficiently

high. This finding is consistent with the TAM model, as certainty in the expected benefits of a technology should enhance a risk-averse official's preference for that technology. But it also provides an illustration of how bias might factor into the TAM model. Specifically, bias can exaggerate the impact of a technology's perceived benefits on a public official's decision-making.

We focus on the policy area of election administration, but the nature of the biases tested are not clearly tied to this particular area and might be expected to be found more widely among public officials dealing with technology and broader policy decisions. Indeed, the variables tested draw from very general theories of human cognition. It is reasonable, therefore, to expect that such cognitive biases are a routine aspect of decision-making in the public sector.

Decision heuristics do not necessarily lead to sub-optimal outcomes, and may reflect the implicit knowledge gain through experience (although the model we test controls for experience). Our study merely points out that technology preferences are driven by more than conscious cost-benefit calculations. But it is easy to imagine the potential danger of the biases found here. Public officials may be reluctant to replace problematic technology if they hold a status quo bias, and may make mistakes in adopting new technology as a result of overconfidence in their own judgment. A faith in technology may blind public officials to the negative qualities of new innovations, leading them to prefer a novel and complex technology that may be inferior to an older, cheaper, or simpler solution. If faith in technology is a widespread and consistent bias among public officials, it may be appropriate to encourage a more pragmatic, or even pessimistic, view of technology as a counterbalance (Goldfinch 2007). At the very least, policy actors with general proclivities toward technology should attempt to account for them explicitly when they make decisions regarding technology adoption.

Our results suffer the usual limitations of those generated using cross-sectional data. Causality is difficult to conclusively attribute, and the dynamic nature of change in election administration makes it uncertain how long the attitudes we describe will remain in place. In addition, the nature of our data prevents us from exploring policy diffusion by considering factors such as geographical proximity and professional networks (Rogers 1962; Norris and Moon 2005). But the general absence of research on cognitive bias in public settings underlines the policy and theoretical relevance of our findings. The results suggest that researchers interested in understanding the preferences and decisions of public officials should supplement models based on rationality with ones that reflect the biases that arise from cognitive dissonance and decision frames.

Notes

1. The characteristics of the different systems are as follows. With punch card ballots, voters mark their preferences by punching holes into numbered boxes on ballot cards. A computerized tabulation machine reads the cards by identifying the holes and then tallies the votes. With lever machines, voters mark their preferences by pulling a lever located next to a chosen candidate's name. The voting machine records and tallies the votes. With central-count optical scan, voters mark their preferences on a computer readable paper ballot. A computerized tabulation machine tallies the votes at a central location. With precinct-count optical scan, voters mark their preferences on a computer readable paper ballot. A computerized tabulation machine tallies the votes at precinct location. For DREs, voters mark their preferences by finding their candidate on a computer screen and directly touching the screen or a button. The computer tabulates the votes.

2. The issue of representativeness applies only to the population of local election officials, not the general population, although the results are consistent even if we weight the data to be consistent with the relationship between number of election officials and the general population. We sought to track respondent representativeness in a number of ways. Because all that we know about non-respondents are their names, we could not check for non-response bias thoroughly by comparing the demographic characteristics of respondents and non-respondents. However, by examining the first names of sampled officials we deduced that 77 percent of sampled officials are female, which is close to the 75 percent of respondents who identified themselves as female. We also sought to check how representative our sample is by comparing the demographic characteristics of respondents to those of the population of local officials. Unfortunately, to our knowledge, publicly available data from other national surveys of these officials do not include demographic variables. But the demographic characteristics of respondents are virtually identical to those we obtained via a later wave of this survey, and the average age and level of education of respondents is virtually identical to those we obtained in a recent survey of Wisconsin's 1,851 election officials.

3. We imputed data using the multiple imputation commands in Stata 11. We used multivariate normal data augmentation to impute missing values of continuous variables. This procedure created five datasets with imputed values, which we then used to estimate our models using Stata's "mi estimate" command. Note that we did not impute values for indicator variables (e.g., *DRE*), nor did we impute values for the dependent variable *media critic* or state indicators. This is why our models are estimated using slightly fewer than 1,512 cases.

4. We estimated fixed effects models to account for state-level policies and pronouncements that might have an influence on local election officials' attitudes towards DREs. There have

been substantial differences across state governments with regard to their positions and roles in the adoption of new voting systems. Some have embraced DREs; others have been critical of DREs and have imposed requirements such as those for voter-verifiable paper ballots; and some have remained relatively passive (Electionline 2008).

5. An additional methodological issue that might concern readers has to do with selection bias. While this is not a problem for our main test of “faith in technology” bias, it might affect our test of status quo bias. The fear might be that we overestimate the impact of status quo bias on preferences for DRE machines because we do not model the adoption of DRE machines explicitly. To account for this possibility, we estimated treatment effects models using our key predictor variables (as well as a variable that captures how much of an influence the 2000 elections had on the adoption of a new system) in the selection equation. The model yielded results similar to those we report.

Table 1. Tests of Cognitive Bias Hypotheses

	Preference for DREs		Preference for DREs		Media too Critical
	(1) All Officials	(2) All Officials	(3) Officials w/ Purchasing Pwr	(4) Officials w/out Purchasing Pwr	(5) All Officials
Main Predictors					
faith in technology bias	0.107*** (0.01)	0.104*** (0.013)	0.113*** (0.016)	0.091*** (0.023)	0.030^ (0.016)
status quo bias (currently using DRE)	0.710** (0.180)	0.629** (0.174)	0.769** (0.231)	0.573^ (0.271)	0.081 (0.187)
own judgment bias (confidence in DRE knowledge *benefits) DRE rating		0.001*** (0.0001)			0.149*** (0.032)
Cost-Benefit of DREs					
benefits	0.009** (0.002)	0.003 (0.003)	0.009* (0.002)	0.007* (0.003)	0.003* (0.001)
low cost	0.006 (0.041)	-0.001 (0.041)	-0.005 (0.020)	0.027 (0.050)	-0.030 (0.021)
Trust in DREs	0.104*** (0.013)	0.100*** (0.013)	0.104*** (0.015)	0.107** (0.023)	0.018 (0.013)
Professionalism					
purchasing power	-0.036 (0.098)	-0.033 (0.096)			0.008 (0.105)
elected	0.052 (0.103)	0.047 (0.101)	0.058 (0.115)	0.069 (0.168)	-0.120 (0.128)
adoption influence	-0.014 (0.028)	-0.015 (0.025)	-0.015 (0.031)	-0.018 (0.034)	0.015 (0.025)
hours per week	0.002 (0.004)	0.002 (0.004)	0.003 (0.005)	0.002 (0.005)	0.007 (0.004)
salary	0.028 (0.035)	0.025 (0.036)	-0.015 (0.035)	0.107^ (0.053)	-0.011 (0.032)
years of experience	-0.015^ (0.007)	-0.014^ (0.007)	-0.018^ (0.008)	-0.008 (0.010)	-0.008 (0.007)
Information					
reliance on vendors	0.005 (0.015)	0.002 (0.014)	0.005 (0.020)	0.006 (0.031)	0.020 (0.021)
confidence in DRE knowledge	0.104* (0.029)	-0.039 (0.053)	0.097* (0.032)	0.112* (0.039)	0.064** (0.023)
Demographics					
age	0.000 (0.007)	0.001 (0.007)	0.004 (0.007)	-0.003 (0.011)	0.004 (0.007)
female	0.088 (0.107)	0.80 (0.106)	0.181 (0.125)	-0.069 (0.158)	-0.133 (0.120)
education	-0.073 (0.058)	-0.060 (0.056)	-0.026 (0.057)	-0.173 (0.115)	-0.011 (0.061)
constant	0.428 (0.554)	1.743** (0.587)	0.102 (0.540)	1.045 (0.919)	1.778** (0.495)
N	1,468	1,468	1,036	432	1,468
F statistic	37.39***	35.44***	32.26***	31.01***	13.10***

Note: The dependent variable in models 1-4 is *preference for DREs*, for which higher values indicates a relative preference for DREs over other systems. The dependent variable in model 5 is *critical media*, for which higher values indicate that respondents “strongly agree” that the media is too critical of DREs. Standard errors clustered by state are in parentheses below the OLS regression coefficients. Significance levels are based on two-tailed tests: ***p<0.001; **p<0.01; *p<0.05; ^p<0.10

Appendix. Variable Descriptions

Name	Description	mean	s.d.
preference for DREs	Response to “How do you feel about the use of the following types of voting systems for elections in the United States?” (7 = strongly support, 1 = strongly oppose) for DREs – minus average response for other types of election systems (lever machines, punch card ballots, paper (hand-counted) ballot, central count optical scan, precinct count optical scan). The scale is adjusted to begin at zero.	6.03	2.19
critical media	Response to “to what extent do you agree or disagree with the following statements?” (7 = strong agree, 1 = strongly disagree): The media reports too many criticisms of DREs	4.51	1.73
faith in technology	Summative index (cronbach alpha = .744) based on response to “to what extent do you agree or disagree with the following statements?” (7 = strong agree, 1 = strongly disagree): The use of new information technologies can dramatically improve government services; The benefits of new technologies greatly outweigh the risks; Overall, e-government has a positive effect on the way government operates.	14.14	3.57
Currently uses DRE	Indicates whether (1) or not (0) a respondent selected DRE in response to following question: “What is the current main voting system, by this we mean the kind of voting system that most voters in your jurisdiction cast their votes with?”	0.17	
DRE rating	Response to “How do you feel about the use of the following types of voting systems for elections in the United States?” (7 = strongly support, 1 = strongly oppose) for DRE.	4.84	1.96
benefits	Index (cronbach alpha = .931) based on response to “How would you rate DREs on the following characteristics?” (7 = excellent, 1 = poor): Reliability; Security; Accuracy in vote counting; Ease of use by poll workers; Ease of use by voters Response to above items were weighted by response to “When considering the quality of voting systems, how important are the following attributes?” (7 = extremely important, 1 = not important at all) for the same items.	236.98	71.43
low cost	Summative index (cronbach alpha = .918) based on response to “How would you rate DREs on the following characteristics?” (7 = excellent, 1 = poor): Acquisition costs; Maintenance costs.	8.48	3.56
trust DRE technology	Summative index (cronbach alpha = .938) based on response to “to what extent do you agree or disagree with the following statements?” (7 = strong agree, 1 = strongly disagree): DRE software is vulnerable to viruses and other malicious software (reversed); DRE software is vulnerable to being hacked (reversed); DREs are more vulnerable to tampering than other types of voting systems (reversed).	12.92	5.35
purchasing power	Indicates whether (1) or not (0) a respondent selected “purchasing” in response to “Are you responsible for any of the following aspects of election technology?”	0.70	
elected	Indicates whether (1) or not (0) a respondent selected “elected” in response to “What is the nature of your position?”	0.64	
adoption influence	Response to “If your jurisdiction were going to be making decisions on the adoption of voting systems in the near future, what best describes the amount of influence the following actors would have?” (10= “A Large Amount of Influence”, 1 = “No influence”): My own influence.	7.28	2.77
hrs per week	Response to “On average how many hours per week do you spend on election duties?”	20.62	16.90
salary	Response to “Please selected your salary range” (Twelve categories from “Less than \$10,000” to “More than \$120,000”)	4.95	2.13
years of experience	Response to “How long have you served in your current capacity in election administration?”	11.89	8.59
reliance on vendors	Response to “To what extent do you rely on the following sources of information about voting systems?” (10 = a great deal of reliance, 0 = no reliance): Vendors.	5.79	2.89
confidence in DRE knowledge	Summative index (cronbach alpha = .932) based on response to “To what extent do you agree with the following statements?” I understand how DREs operate; I have adequate information on DREs to assess whether they are a good choice for my jurisdiction.	8.90	3.92
age	Response to “How old are you?”	52.99	9.63
female	Indicates whether (1) or not (0) the respondent selected “Female” in response to “Are you male or female?”	0.75	
education	Response to “What is the highest level of education you have completed or the highest degree you have received?” (1 = Completed some high school; 2 = High school graduate or equivalent; 3 = Completed some college, but no degree; 4 = College graduate; 5 = Completed some graduate school, but no degree; 6 = Completed graduate school)	3.38	1.16

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