Journal of Information Technology & Politics

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/witp20

In cyber we trust? Understanding election legitimacy in the age of electronic election systems

Gregg R. Murray & Craig Douglas Albert

To cite this article: Gregg R. Murray & Craig Douglas Albert (19 Jan 2025): In cyber we trust? Understanding election legitimacy in the age of electronic election systems, Journal of Information Technology & Politics, DOI: 10.1080/19331681.2025.2453913

To link to this article: https://doi.org/10.1080/19331681.2025.2453913

JOURNAL OF INFORMATION TECHNOLOGY & POLITICS
https://doi.org/10.1080/19331681.2025.2453913

Routledge
Taylor & Francis Group

In cyber we trust? Understanding election legitimacy in the age of electronic election systems

Gregg R. Murray and Craig Douglas Albert

ABSTRACT

This study asks the question "to what extent do electronic election systems affect perceptions of election legitimacy in the U.S.?" The use of these systems is growing in the U.S. and abroad. Frequently, the justification for using electronic technology in election administration is that it reduces human-induced error – accidental error or intentional fraud – making elections cleaner and more credible. This study examines the effects on perceived election legitimacy of two electronic election technologies: electronic poll books and biometric voter identity verification. Poll books are record-keeping devices that allow election officials to determine which individuals are eligible to vote and where. Voters match their identity in the poll book to confirm they are eligible to vote. Electronic technology exists and is used for both poll books and voter identity verification. This pre-registered study tests these ideas in a pair of survey experiments conducted with samples of voting-age adults in the U.S.

KEYWORDS

Electronic election systems; electronic poll books; biometric voter verification; election legitimacy; electoral systems

Introduction

The controversial 2000 U.S. presidential election with its "hanging chads" and delayed vote tallies motivated the Help America Vote Act of 2002 (HAVA), which led to several voting reforms. One result of HAVA has been the increased use of electronic election systems. Some believe these systems can reduce the time required to vote as well as reduce human-induced errors related to issues such as managing paper-based voter lists, transcribing post-election results, and committing electoral fraud (Desmarais et al., 2015; MIT Election Data + Science Lab [MEDSL], 2022; Schwarzmann, 2021). Overall, the proposed effect is that electronic technology can make elections more legitimate. This study is designed to test that assertion.

Individuals in the U.S. generally go through a three-step process to vote in person: (1) arrive at the polling location, (2) check-in and verify identity, then (3) cast a ballot (Spencer & Markovits, 2010). Check-in and identity verification (step 2) are typically based on poll books. Minimally, poll books list the names and addresses of people eligible to vote at a voting location. Broadly speaking, they are used to manage voter registration records and check in voters at polling locations on Election Day (Merrill, 2015, p. 5). Historically, this has generally been accomplished by election officials generating and printing paper copies of registered voter lists in the form of poll books, which poll workers then consult to verify voter eligibility at polling locations. Voters typically verify their identity by showing a form of identification, usually a government-issued identification card, which is compared to the voter's information in the poll book. Once verified, the poll worker directs the voter to a voting booth to cast a ballot (step 3). The objective of step 2 is for voters to be checked in correctly, securely, reliably, and quickly and, more broadly, to ensure that all eligible voters can vote and vote at most once.

While data are limited regarding check-in and identity verification, evidence suggests that the use of electronic poll books (i.e., e-poll books) increased from initial statewide deployment in only two states in 2006 (Hubler, 2014) to 78% of jurisdictions in 2020 and then to 83% in 2022 (Verified Voting, 2022). Complicating the widespread adoption of

CONTACT Craig Douglas Albert calbert@augusta.edu Department of Social Sciences, Augusta University, Aug 1120 15th Street Allgood Hall N309, Augusta, GA 30912

Supplemental data for this article can be accessed online at https://doi.org/10.1080/19331681.2025.2453913

electronic election systems, though, is recent concern that foreign governments have attempted to influence U.S. elections by electronically attacking elections systems (Office of the Director of National Intelligence [ODNI], 2017; U.S. Senate Select Committee on Intelligence, 2019). Given this information, it is not surprising that in a 2018 survey of U.S. adults, 55% indicated they are "not too confident" or "not at all confident" that U.S. elections systems are secure from hacking and other technological threats. Further, 44% said they are "not too confident" or "not at all confident" that the U.S. is making serious efforts to protect election systems from these types of threats (Pew Research Center, 2018). This evidence suggests that a large proportion of the U.S. population has concerns about the security of the country's election systems, and part of that concern arises from issues related to electronic technologies.

This pre-registered study is designed to assess how electronic election systems affect individuals' perceptions of election legitimacy. It tests this question using two National Science Foundation (NSF Award Number 2131538)-funded survey experiments conducted with samples of voting-age adults in the U.S. Both experiments address electronic technologies – electronic poll books and biometric identity verification – that may facilitate step 2 of the three-step voting process. The paper proceeds with the following sections. First, it provides a literature review designed to briefly articulate the current understanding of key electoral concepts regarding electronic technology as well as election legitimacy. Second, it describes the experimental data and methods used in the analyses. Third, the paper presents the results followed by, finally, a discussion including probable implications regarding electronic election systems and election legitimacy. This study adds to the elections and election administration literatures by seeking to understand the effect of adding electronic systems to the election process on perceived election legitimacy.

Literature

Given evidence suggesting a significant and growing role of technology in election systems (e.g., Hubler, 2014; Verified Voting, 2022) as well as substantial belief that U.S. elections systems are not secure against technological attacks (Pew Research Center, 2018), it is reasonable to conclude that the technology used in step 2 of the voting process – voter check-in and identity verification – may play a role in people's assessments of election legitimacy. We assess this through the lens of literatures regarding election technology, in terms of electronic poll books and biometric voter identification, and political legitimacy.

As used here, an electronic election system uses digital technologies to perform functions such as voter registration, voter eligibility verification, and results transmission. There has been a substantial increase in the use of electronic election systems around the world (Cheeseman et al., 2018). Since its controversial 2000 presidential election, the U.S. has also increased its use of electronic election systems (Desmarais et al., 2015; MEDSL, 2022). For instance, the use of electronically scanned ballots increased from about 25% in 2000 to about 70% in 2016 (MEDSL, 2022, Figure 2). More specifically, evidence indicates that the adoption of electronic poll books has grown significantly, starting with their introduction in just two U.S. states in 2006 (Hubler, 2014), expanding to 78% of jurisdictions by 2020, and further increasing to 83% by 2022 (Verified Voting, 2022). As well, reports suggest that the use of biometric technologies has grown significantly in election systems for voter registration, verification, and identification (Wolf et al., 2017, pp. 11–12). For example, the IDEA "ICTs in Elections Database" reports that almost 50 countries use fingerprints for purposes of voter registration and identification (accessed June 23, 2023).

Electronic poll books

Although an essential part of the electoral process and increasingly implemented, there has been surprisingly little literature written about electronic poll books. Schwarzmann (2021) notes several flaws in the current configuring of e-poll books including, a) problems with e-poll book synchronization, which leaves a window of vulnerability allowing bad actors the chance to cast more than one vote; b) the difficulty of replacing crashed devices, which risks data loss; and c) other insecure

systems connected to the e-poll book, which could allow bad actors to eavesdrop and launch impersonation attacks.

These issues add to the privacy concerns connected to electronic voting systems generally, and specifically illustrated by Popoveniuc et al. (2011) who note that while there are some advantages to e-poll books over paper poll books, they have been known to inadvertently record the order of voter check-in, violating ballot secrecy and thus, privacy. In a 2023 report on the usability and accessibility of electronic poll books, the authors demonstrate potential pros and cons of the systems. They note advantages such as shorter check-in times, increased efficiency for voters finding their correct polling station, increased accuracy for voter rosters, and reduced time for updating voter records post-election. However, these come with potential disadvantages such as the uncertainty associated with adopting new technology, the acceptance of e-poll books by poll workers, the costs of implementation, and concerns about the security of new technologies (Quesenbery et al., 2023).

Besides the limited literature on e-poll books, there has been extensive research on electronic voting systems overall. While only tangentially related to the current project, a brief mention can shed light on overall perceptions concerning electronic voting. Proponents of electronic election systems argue, among other things, that the new technology makes elections "cleaner and more credible" (Cheeseman et al., 2018, p. 1397). They suggest, in particular, that these systems can reduce procedural problems or administrative mismanagement or malfeasance which, in turn, increases an election's legitimacy (Cheeseman et al., 2018). In the U.S. case, some contend electronic election systems reduce human-induced errors that can lead to mismanaged paper-based voting lists, inaccurately transcribed post-election results, and increased electoral malfeasance (Desmarais et al., 2015; MEDSL, 2022; Schwarzmann, 2021).

Opponents, on the other hand, suggest that the ideal of cleaner, more credible elections through the use of electronic technology is overly optimistic. Electronic technology is often complicated to implement and operate properly, and it is relatively unreliable operationally compared to predecessor technologies like paper-based systems (Cheeseman et al., 2018, p. 1405). In the case of electronic election systems, both voters and poll workers must be trained to use the system competently to maintain confidence in election results (Ryan et al., 2015). Further, interconnected systems can be subject to mass malfunction, a particularly damaging problem when it occurs on election day. Further, the nontrivial possibility of singular equipment malfunctions requires widespread and expensive backup equipment to mitigate (National Conference of State Legislatures [NCSL], n.d.).

Biometric identity verification

The method by which voters verify their identity in step 2 of the voting process has been the subject of considerable debate and controversy (e.g., Endres & Panagopoulos, 2021). Proponents of stricter voter identification procedures suggest such procedures reduce voter fraud and promote election integrity (Mazo, 2019). Opponents note that consequential voter fraud is rare, which makes strict identification requirements unnecessary. Other opponents indicate that identity verification requirements are not implemented evenly across polling locations and voter groups, which disadvantages some groups relative to others (Atkeson et al., 2010). In the U.S., for instance, Matthew DeBell, a senior research scholar for the American National Elections Studies, estimated that around 3% of voting-age adults do not have appropriate identification to vote thereby disenfranchising 6–9 million potential voters (e.g., Larsen, 2018). In particular, research indicates that racial and ethnic minorities in the U.S. are less likely relative to non-minorities to have the forms of identification necessary for voting (e.g., Barreto et al., 2019). Both perspectives suggest that how voters verify their identity may play a role in the perceived legitimacy of an election.

Electronic election systems may offer solutions to identity verification. Technologists have proposed biometric solutions for government-related activities such as "access control, border security, citizen registration, passports and identification cards," as well as elections (Wolf et al., 2017, p. 11). Biometric systems use individuals' unique physical characteristics to automate their identification. Biometrics have specifically been

proposed for voter identification, including using fingerprint, facial recognition/imaging, signature, and iris scanning technologies (e.g., Alim et al., 2017; Megalingam et al., 2022; Wolf et al., 2017). Indeed, Wolf et al. (2017), pp. 11–12) note that the use of biometric technologies has grown significantly in election systems for voter registration, verification, and identification. For example, the IDEA "ICTs in Elections Database" reports that 47 countries use fingerprints for voter registration and identification (accessed June 23, 2023). This is particularly the case in African and Latin American voting systems. Wolf et al. (2017), p. 10) attribute the growing use to desire for "increasing trust in the electoral process by enfranchising all eligible citizens and, at the same time, reducing various forms of electoral fraud." They argue that biometric technology can lead to significant improvements when "citizens do not have reliable and trusted identification documents that can be used for voter registration" (2017, p. 14).

Other than technical literature on design and development (e.g., Deepika et al., 2017), research on biometric voting systems is quite limited. Effah and Debrah (2018) concluded that the use of biometric technology for voter identification and verification in Ghana's 2012 general elections failed primarily due to a lack of real-time connectivity and inadequate training of election officials. On the other hand, Debos (2021, p. 1406) argued that biometric voter registration in Chad serves a positive "disciplining" function by "framing of democracy in narrow technological and procedural terms."

Given the paucity of related research, research from other domains may be informative. The use of biometrics in consumer behavior has been growing, and people's trust in biometric-aided consumer transactions has been studied. One study found that nearly equal proportions (46% versus 47%) of international respondents, including U.S. respondents, agreed (versus disagreed) with a statement that "using facial or fingerprint recognition technology to verify my identity" means they would never be the victim of fraud (Paysafe Group, 2019). This suggests that a substantial proportion of respondents were cautious in their beliefs about this technology. On the other hand, the most likely mentioned benefits of using biometrics to pay for goods and services online were they are quick and convenient (2019, p. 17).

Recognizing concerns about the costs of acquiring valid voter identification (e.g., Larsen, 2018), particularly for some groups relative to others (Barreto et al., 2019), convenience, in particular, may affect attitudes toward the use of biometrics for voter identification. Because everyone's biometric information is always on their body, it should be easier to produce at check-in and would not require a voter to acquire and carry a traditional form of identification. In this case, adding biometric identification to the limited list of potential forms of identification would increase a voter's ability to verify identification and therefore make the voting process less costly and possibly enfranchise, even in bureaucratically and administratively developed countries like the U.S., significant numbers of voters.

Political legitimacy

Political legitimacy is a contested term but can generally be thought of as encompassing people's beliefs about the suitability of the existing political system and institutions for a society (Lipset, 1960, p. 77) or, more consequentially, people's beliefs about political authority and their obligations to that authority (Weber, 1921/1978). Many contend that a lack of political legitimacy in established democracies, such as the U.S. and Canada, hinders confidence in democracy, undermines political participation, including voting, and as a result alters political representation (e.g., Norris, 2014, p. 6). As the concept evolved, two approaches to understanding political legitimacy emerged: macro or institutional characteristics and micro or individual attitudes (Weatherford, 1992). The institutional approach focuses on matters related to representational procedures such as accountability and attentiveness, while the individual approach focuses on political involvement and interpersonal assurances. Weatherford (1992) argued that both interact to play meaningful roles in the individuals' perceptions of a political order's legitimacy.

According to Weber (1921/1978), political legitimacy at the level of society is derived from a long history of a particular social order (traditional

authority), trust in leaders of the social order (charismatic authority), or the legality of the social order (legal authority). Related to legal authority, or "legitimate domination," which is derived from "the legality of enacted rules and the right of those elevated to authority under such rules to issue commands" (Weber, 1921/1978, p. 215), evidence suggests that the legitimacy of public policy is affected by procedural fairness (van der Eijk & Rose, 2021). Procedural fairness reflects conceptions that authorities act fairly, which is broadly captured in terms of their fair, honest, impartial, and ethical behavior and their provision of representation and error correction opportunities (Tyler, 1988). In particular, it focuses on the process used to reach an outcome and how fair, predictable, and transparent processes strengthen the legitimacy of an outcome (Varney, 2009). While fair procedures are not a panacea for concerns with institutional legitimacy (e.g., see Mondak, 1993 regarding perceptions of the legitimacy of the Supreme Court), substantial research shows that individuals are likely to accept outcomes, even ones they disagree with, as long as they believe the procedures leading to those outcomes are fair (Tyler, 1990, 2003; Tyler & Huo, 2002; see also Magalhães & Abril, 2018).

Regarding election legitimacy, there is considerable evidence that citizens who support the winning side in a democratic contest are more likely to support and trust the government system than those on the losing side (e.g., Anderson et al., 2005; Banducci & Karp, 2003). But van der Eijk and Rose (2021), p. 105) assert a role for procedural fairness by concluding that "procedural fairness is of crucial importance because it relates to the democratic basis of the legitimacy of governments." It is reasonable to assume that greater procedural fairness in elections would add to the legitimacy of the election and the state conducting the election. At a broad level, Birch (2008) reported that voter turnout is higher when voters believe an election is fair. More specifically to legitimacy, evidence has been presented regarding the effects of election administration on national political legitimacy. For instance, an analysis of eight countries in Africa suggested that individuals' experiences with how elections were conducted were related to their sense of individual political efficacy which, in turn, played an important role in the development of government legitimacy (Elklit & Reynolds, 2002). Berman et al. (2019) found in a field experiment in Afghanistan that employing fraud-reducing technology for an election led to more positive attitudes toward the government and willingness to comply with governance. Grimes (2006) found that people's perceptions of procedural fairness related to a large-scale land-use matter regarding railway construction were positively associated with their trust in the railway authority and willingness to accept the railway authority's decision outcome. This literature suggests that step 2 of voting and, therefore, poll books and identity verification, are strongly enmeshed in conceptions of political legitimacy.

Hypotheses regarding electronic poll books

Experiment 1 assesses how the use of electronic poll books affects perceptions of an election's legitimacy. The authors deduce four hypotheses from the reviewed literature related to this question that together propose a mediated relationship between the use of electronic poll books and perceptions of an election's legitimacy. Broadly, the expectation is that the use of electronic poll books (compared to paper poll books) will lead to perceptions of increased procedural fairness. Perceptions of increased procedural fairness then will lead to perceptions of increased election legitimacy, though the use of electronic poll books will also have an independent effect on perceptions of election legitimacy. The following figure represents the hypothesized relationships.

The Help America Vote Act of 2002, which was enacted to improve U.S. voting systems, has led to a significant increase in the use of electronic election systems. In particular, Desmarais et al. (2015) concluded that electronic poll book systems would reduce human-caused errors related to managing paper-based voter lists.

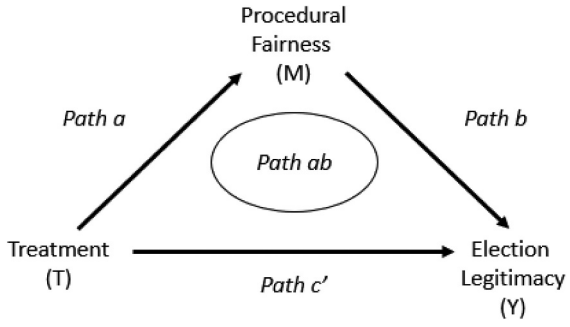

Figure 1. The hypothesized mediated relationship.

Procedural fairness is broadly defined as a process in which people act honestly and impartially and provide opportunities for representation and *error correction* [emphasis added] (Tyler, 1988). Identified as *path a* on Figure 1, this suggests the following hypothesis:

Hypothesis 1a. The use of an electronic poll book at voter check-in will increase a voter's perception of an election's procedural fairness relative to non-electronic poll books.

A great deal of research suggests that people are likely to accept outcomes as long as they believe the procedures leading to those outcomes are fair (e.g., Tyler, 1990). van der Eijk and Rose (2021) directly associated procedural fairness with government legitimacy, while Grimes (2006) found that perceptions of procedural fairness were positively associated with people's willingness to accept the outcome of a large-scale public works project. Identified as *path b* on the figure, this evidence suggests the following hypothesis:

Hypothesis 1b. A voter's increased perception of an election's procedural fairness related to the use of an electronic poll book at voter check-in will increase the voter's perception of an election's legitimacy.

The hypothesized positive relationships between the use of electronic poll books and procedural fairness (H1a) and then procedural fairness and perceptions of election legitimacy (H1b) suggest the following mediated/indirect effect, which is identified as *path ab* on the figure:

Hypothesis 1c. The perception of an election's legitimacy will be at least partially attributable to a perception of procedural fairness that is stimulated by the use of an electronic poll book at voter check-in.

The role of electronic technology in election administration is growing (e.g., Hubler, 2014). HAVA has encouraged the use of improved election technology to, among other things, reduce human error in elections, while some scholars suggest greater reliance on electronic election systems may undermine public confidence in electoral systems (e.g., Moynihan, 2004). Further, some public opinion research shows the public has concerns about the security of election systems against technological attacks (Pew Research Center, 2018). It is reasonable to conclude that the use of technology in and of itself may have a direct effect on perceptions of an election's legitimacy. Thus, the discussion is unsettled on how electronic technology might affect people's perceptions of election legitimacy. For purposes of parsimony, we suggest the following direct effect, which is identified as *path c'* in the figure:

Hypothesis 1d. The use of an electronic poll book at voter check-in will increase a voter's perception of an election's legitimacy relative to non-electronic poll books.

Hypotheses regarding biometric identity verification

Experiment 2 assesses how the use of biometric identity verification may affect perceptions of an election's legitimacy. The authors deduce four hypotheses from the reviewed literature related to this question that together propose a mediated relationship between the use of biometric identity verification and perceptions of an election's legitimacy. Broadly, the expectation is that the availability of biometric identity verification (compared to conventional identity verification only) will lead to perceptions of increased procedural fairness. Perceptions of increased procedural fairness then will lead to perceptions of increased election legitimacy, though the use of biometric identity verification will also have an

independent effect on perceptions of election legitimacy. Figure 1 also depicts these hypothesized relationships.

The use of biometrics in election systems has grown significantly. Wolf et al. (2017) attribute this growth to the desire of governments to improve trust in the electoral process by increasing confidence that eligible citizens are able to vote, thereby increasing voter enfranchisement, and decreasing concerns about electoral fraud. Both improvements are likely related at least to increased error correction and representation. Identified as *path a* on Figure 1, this suggests the following hypothesis:

Hypothesis 2a. The ability to verify one's identity biometrically at voter check-in will increase a voter's perception of an election's procedural fairness relative to conventional identity verification only.

Using the same argument regarding the connection between procedural fairness and government legitimacy offered for H1b and identified as *path b* on the figure:

Hypothesis 2b. A voter's increased perception of an election's procedural fairness related to the use of biometric voter identification at voter check-in will increase the voter's perception of an election's legitimacy.

The hypothesized positive relationships between the use of biometrics for voter verification and procedural fairness (H2a) and then procedural fairness and perceptions of election legitimacy (H2b) suggest the following mediated/indirect effect, which is identified as *path ab* on the figure:

Hypothesis 2c. The perception of an election's legitimacy will be at least partially attributable to a perception of procedural fairness that is stimulated by the ability to verify one's identity biometrically at voter check-in.

The same argument regarding the connection between the use of electronic technology and government legitimacy offered for H1d suggests the following direct effect, which is identified as *path c*' on the figure:

Hypothesis 2d. The ability to verify one's identity biometrically at voter check-in will increase a voter's perception of an election's legitimacy relative to conventional identity verification only.

Data and methods

This pre-registered study tests the effects of electronic election systems on perceptions of election legitimacy using two survey experiments embedded in an online survey of adults nationwide in the U.S. Please see the open science statement at the end of the article for information to access the pre-registration, pre-analysis plan (PAP), data, and materials. The survey was conducted from June 24 to July 5, 2022. The survey and project were reviewed and approved by the authors' Institutional Review Board. The study includes a general population sample of English-speaking, voting-age adults (18 years old or older) residing in the U.S. Individuals who were not at least 18 years old, did not speak English, or did not currently reside in the U.S. were excluded from the study. The sample includes 800 respondents, 50% of whom are registered voters, and 50% are non-registered individuals. The PAP includes a manipulation check for each experiment. Unexpectedly, 41% of the subjects failed the manipulation check in experiment 1, and 46% failed in experiment 2. The sampling plan presented in the PAP calls for a minimum cell size of 63, and the group balance analyses that appear in the second table indicate only one imbalance in one treatment-control group pairing. Therefore, the authors conclude the smaller-than-expected samples do not undermine the statistical power or reliability of the results.

The data were collected by YouGov, which recruited and paid the respondents from part of the fees paid to it for the data collection. The survey includes two experiments with respondents randomly assigned to one of two experimental groups in each experiment (treatment and control). Each

experiment was delivered in the form of vignettes (two experimental groups each) with related images. The first experiment consists of a vignette describing in detail an electronic- or paper-poll book voter check-in process and presents an image showing a white female checking in to vote using one of the two types of poll books. It assesses the effects of the different poll books on perceived election legitimacy. Due to election security restrictions, the researchers did not have access to actual poll books to stage precisely parallel images (see Appendix A). See the Deviations and Limitations section for discussion. The second experiment assesses the effects of the availability of biometrics for voter identity verification on perceived election legitimacy. It consists of a vignette describing a voter check-in process that allows either voter identification using biometrics (facial or fingerprint recognition) or conventional forms of identification (e.g., driver's license) or only conventional forms of identification.

The dependent variables include 16 single-item assessments, six regarding election legitimacy[1] and 10 regarding procedural fairness,[2] of voter check-in systems and biometric identification systems as described in the experimental vignettes. The question set also includes the manipulation check for each experiment. See Table 1 for pertinent desriptive statistics and see Appendix A for all experimental manipulations and pertinent measures.

The mean time for completion was 12.0 mind. Diagnostic tests suggest that randomization succeeded. Table 2 describes the respondents by experimental group as well as in aggregate and shows no statistical imbalance between treatment and control groups except in the proportion of registered voters in experiment 1 (difference = 0.10, $p < .04$). Logit regressions in which group assignment was regressed on the characteristics reported in Table 2 were statistically insignificant (experiment 1: $\chi^2 = 11.32$, $p < .42$, $n = 473$; and experiment 2: $\chi^2 = 14.86$, $p < .19$, $n = 369$), and no individual variable achieved conventional levels of statistical significance in either model (minimum p: experiment 1 registered voter $p = .08$; experiment 2 education indicator $p = .09$).

Table 1. Descriptives.

Variable	N	Mean	SD	Min	Max	Alpha
DEPENDENT						
Legitimacy: E-poll books	466	7.10	2.00	1	10	0.85
Legitimacy: Biometric ID	366	7.28	2.07	0.67	10	0.85
INDEPENDENT						
Experiment 1 treatment	473	0.64	0.48	0	1	
Experiment 2 treatment	369	0.73	0.45	0	1	
Proc Fairness: E-poll books	471	6.86	1.93	1	10	0.85
Proc Fairness: Biometric ID	365	6.84	2.09	1	10	0.88

Table 2. Experimental group balance table.

Experimental Group	Sex/Gender	Age	Race	Education	Party ID	Reg Voter
Poll Book: Paper	female	49.11	white	> HS	Dem	yes
	0.50	(17.95)	0.85	0.77	0.36	0.61*
	[*n* = 162]	[*n* = 169]	[*n* = 169]	[*n* = 169]	[*n* = 169]	[*n* = 169]
Poll Book: Electronic	female	46.98	white	> HS	Dem	yes
	0.53	(17.26)	0.82	0.70	0.38	0.51*
	[*n* = 299]	[*n* = 304]	[*n* = 304]	[*n* = 304]	[*n* = 304]	[*n* = 304]
Voter ID: Conventional	female	47.51	white	> HS	Dem	yes
	0.57	(17.77)	0.86	0.77	0.45	0.59
	[*n* = 100]	[*n* = 100]	[*n* = 100]	[*n* = 100]	[*n* = 100]	[*n* = 100]
Voter ID: Conventional or Biometric	female	45.60	white	> HS	Dem	yes
	0.55	(17.86)	0.78	0.68	0.36	0.53
	[*n* = 269]	[*n* = 269]	[*n* = 269]	[*n* = 269]	[*n* = 269]	[*n* = 269]
Aggregate Sample	female	47.74(17.52)	white	> HS	Dem	yes
	0.55		0.83	0.73	0.37	0.58
	[*n* = 357]	[*n* = 473]	[*n* = 473]	[*n* = 473]	[*n* = 473]	[*n* = 473]

Except for age, which is continuous and reported in mean years with standard deviation in parentheses, the variables are categorical, and entries indicate the modal category and its proportion. * indicates a statistical difference between the treatment and control groups.

Table 3. Bivariate regressions: predicting election legitimacy related to E-Poll books (A) and biometric voter identification (B).

A. Experiment 1	Coef	Coef SE	Cons	Cons SE	N	F	Adj R^2
Treatment	−0.311	0.193	7.299*	0.154	466	2.60	0.00
Proc Fairness	0.817*	0.032	1.454*	0.229	464	651.80*	0.58
B. Experiment 2	**Coef**	**Coef SE**	**Cons**	**Cons SE**	**N**	**F**	**Adj R2**
Treatment	−0.053	0.244	7.320*	0.209	366	0.05	−0.00
Proc Fairness	0.807*	0.031	1.770*	0.220	362	690.28*	0.66

*p < .05, + p < .10 (two-tailed).

Table 4. Multivariate regressions (unmediated): predicting election legitimacy.

	(A) Poll Books		(B) Biometric ID	
	Coef	SE	Coef	SE
Treatment	−0.242+	0.124	−0.085	0.143
Proc Fairness	0.816*	0.032	0.807*	0.031
Constant	1.617*	0.243	1.823*	0.242
N	464		362	
F	329.76*		344.70*	
Adj R^2	0.59		0.66	

*p < .05, +p < .10 (two-tailed).

Analysis plan

The analyses assess treatment effects using bi- and multivariate OLS regression as each dependent variable is measured on a continuous scale. For transparency and to allow readers to evaluate the basic relationships between the dependent variables and treatments in terms of relationship robustness, suppression effects, and confounding (Lenz & Sahn, 2021), Table 3 reports bivariate OLS regression models, and Table 4 reports multivariate OLS regression models, which include the treatment and mediating variables. The treatments are specified as indicator variables where in the first experiment 1 indicates the electronic poll book treatment and 0 the paper poll book treatment, and in the second experiment 1 indicates the conventional or biometric voter identification verification process and 0 the conventional verification process alone. The expectation was that the dependent and independent variables would be approximately normally distributed, so no transformations would be necessary. Post-estimation model diagnostics include tests for multicollinearity, omitted variables, and heteroskedasticity. The expectation was that no adjustments would be needed for multicollinearity or omitted variables, but adjustments would be needed for heteroskedasticity (estimating robust standard errors). See the Deviations and Limitations section for deviations from the PAP.

Finally, because procedural fairness has been found to affect the legitimacy of public policy (van der Eijk & Rose, 2021), the final set of analyses summarized in Figure 2 and detailed in Appendix B use simple mediation analysis (e.g., Baron & Kenny, 1986; Preacher & Hayes, 2004) to assess if concerns about procedural fairness contribute to (i.e., mediate) the relationship between the experimental treatments and perceptions of election legitimacy. The first step is to test whether the

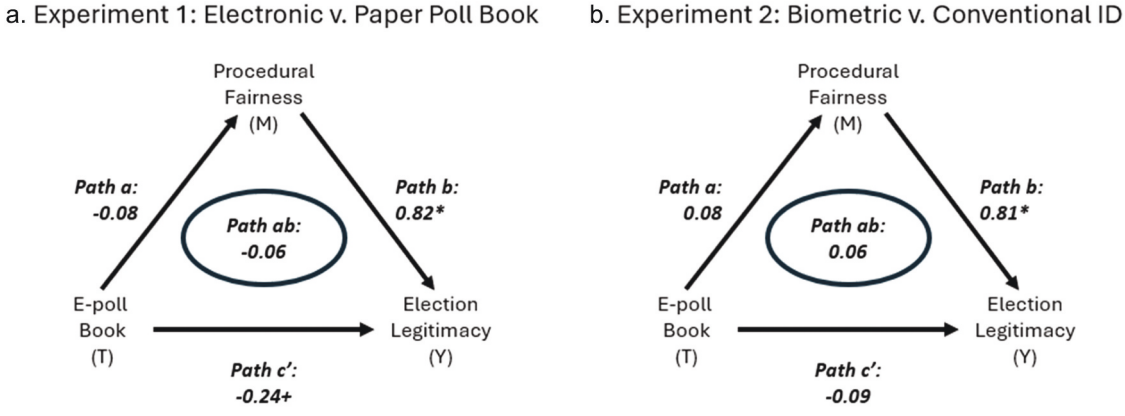

Figure 2. Mediation results summary. Note: *p < .05 +p < .10 (two-tailed)

experimental treatments affected the dependent variable regarding election legitimacy. This represents the total effect of the relationship between the treatment and attitudes about election legitimacy without controlling for the effect of the mediating variable, procedural fairness. Formally, this is *path c*, but it does not appear in Figure 1. The next step is to assess whether the treatments affect perceptions of procedural fairness (the mediator), *path a* in Figure 1. The third step is to evaluate whether procedural fairness (the mediator) affects election legitimacy, *path b* in Figure 1. The final step is to test whether differential perceptions of election legitimacy are linked to the experimental treatments through perceptions of procedural fairness, the mediator representing the indirect effect (Preacher & Hayes, 2004), *path ab* in Figure 1. This last step also tests the direct effects or independent effects of the experimental treatments on attitudes regarding election legitimacy while controlling for the effect of the mediating variable, procedural fairness. The last step also tests whether the experimental treatments affected the dependent variable regarding election legitimacy while controlling for the effect of the mediating variable, procedural fairness, *path c'* in Figure 1.

The analyses were completed using Stata 18. All statistical tests are two-tailed unless noted otherwise. There is no known literature upon which to base estimated effect sizes for these treatments. As such, the authors assumed a mean of 5 on a 0–10 outcome measure with a standard deviation of 2 in the control group and a 10% decrease in mean in the treatment group with equal assignments to the two experimental groups of each experiment. Further parameters include an alpha of 0.05, beta of 0.2, and power of 0.8. With these parameters, each treatment group should include 63 respondents for a total sample of at least 126.

Results

The PAP assumed the primary dependent variables – election legitimacy related to poll book type and identity verification process – would be normally distributed, but statistically they are not. Further analyses suggested that transformations, such as squaring them, did not meaningfully improve their distributions or model fit, so they remain in their unaltered form for the analyses to preserve intuitive interpretation of the results. The PAP also assumed heteroskedasticity in the regression models, but diagnostics indicate this is not the case in all the models. Therefore, the analyses use model-based not robust standard errors.

Bivariate regressions

Table 3 presents the bivariate OLS regression results for experiment 1 regarding poll books (panel A) and experiment 2 regarding biometric identity verification (panel B). In each case, the dependent variable, perceived election legitimacy, is regressed individually on the experimental treatment variable and perceived procedural fairness.

Regarding Hypothesis 1a, the bivariate regression results in panel A indicate poll book type – electronic versus paper – had no statistically discernible effect on election legitimacy (−0.311, $p = .11$), but, regarding hypothesis 1b, perceived procedural fairness had a statistically and substantively significant positive effect on election legitimacy (0.817, $p < .001$). The bivariate regression results in panel B suggest a similar pattern. Regarding Hypothesis 2a, the voter identification process – conventional or biometric versus conventional only – had no statistically discernible effect on election legitimacy (−0.053, $p = .83$), but, regarding hypothesis 2b, perceived procedural fairness had a statistically and substantively significant positive effect on election legitimacy (0.807, $p < .001$). In terms of Hypotheses 1a and 2a, these preliminary results suggest that these electronic election technologies – electronic poll books and biometric identity verification – have no effect on perceived election legitimacy compared to predecessor technologies – paper poll books and conventional forms of voter identification, but perceived procedural fairness does.

Multivariate regressions (no mediation)

The hypotheses suggest that the relationship between the experimental treatments and perceived election legitimacy is mediated by perceptions of procedural fairness. However, it is reasonable to run a conventional, unmediated model to estimate the effects. Table 4 presents the

multivariate OLS regression results for experiment 1 regarding poll books (model A) and experiment 2 regarding biometric identity verification (model B). In each case, the dependent variable, perceived election legitimacy, is regressed on the experimental treatment variable and perceived procedural fairness. Some scholars add covariates to these models to control for omitted variable bias or to attempt to increase the precision of the estimated treatment effect (Montgomery et al., 2018). But tests reported in the Data and Methods section indicate that randomization of experimental group assignment was successful, and the experimental groups are largely balanced, so there is no reason to make this adjustment.

Model A of Table 4 reports the OLS results for experiment 1 regarding poll book type. The model is statistically significant ($F = 329.76$, $p < .001$) and has substantial explanatory power (adjusted $R^2 = 0.59$). Following the PAP, diagnostics indicate concerns with heteroskedasticity (i.e., Breusch-Pagan/Cook-Weisberg heteroskedasticity test: $p = .02$) and omitted variable bias (i.e., Ramsey RESET test: $p = .04$) but not multicollinearity (i.e., mean VIF = 1.00). Heteroskedasticity does not bias estimates, but it can reduce p-values. As the coefficients for the treatments are signed in the wrong direction regardless of statistical significance, this is only of concern for the measure of procedural fairness. But the magnitude of the effect of procedural fairness is so large, it seems unlikely that it is deflating the p-value to an extreme degree. On the other hand, given the substantial explanatory power of the model and successfully randomized assignment to experimental groups, omitted variable bias seems to be a limited threat. Given these and the desire for reasonable model parsimony, these issues are not addressed.

The multivariate regression results in model A indicate poll book type – electronic versus paper – had a marginally statistically discernible negative effect on election legitimacy (−0.242, $p = .052$). Substantively, that indicates that an electronic poll book was associated with a 0.2-point drop in perceived election legitimacy (scaled 0 to 10). Further, perceived procedural fairness had a statistically significant positive effect on election legitimacy (0.816, $p < .001$). Substantively, that indicates a 1-point increase in perceived procedural fairness was associated with a 0.82-point increase in perceived election legitimacy. Overall, this initial evidence suggests that poll book type may be related to perceived election legitimacy, but the relationship is opposite of what was hypothesized – electronic poll books seem to undermine, not boost, election legitimacy (reference Hypothesis 1d).

Model B of Table 4 reports the OLS results for experiment 2 regarding identity verification process – conventional or biometric versus conventional only. The model is statistically significant ($F = 344.70$, $p < .001$) and has substantial explanatory power (adjusted $R^2 = 0.66$). Following the PAP, diagnostics indicate some concerns with heteroskedasticity and omitted variables but not multicollinearity (i.e., Breusch-Pagan/Cook-Weisberg heteroskedasticity test: $p < .001$; Ramsey RESET: $p < .05$; but mean VIF = 1.00). Following the argument for the same issues regarding experiment 1, no adjustments are made for these issues.

The multivariate regression results in model B indicate identity verification process had no statistically discernible effect on election legitimacy (−0.085, $p = .55$). Perceived procedural fairness, on the other hand, had a statistically significant positive effect (0.807, $p < .001$). Substantively, that indicates a 1-point increase in perceived procedural fairness was associated with a 0.81-point increase in perceived election legitimacy. Overall, this initial evidence suggests that the availability of biometric identity verification is not statistically discernible from only conventional identity verification regarding perceived election legitimacy (reference Hypothesis 2d).

Mediation analysis

While the basic multivariate regressions provide evidence of the direct relationships between election legitimacy and poll book type as well as the identity verification process, the hypothesized relationships are that procedural fairness mediates the relationships between the experimental treatments and election legitimacy as indicated in Figure 1.

Figure 2 summarizes the results of the formal causal mediation models. The full model results appear in Appendix B. *Path a* represents the effect

of the experimental treatments (T) on procedural fairness, the mediator (M). These are the tests of H1a and H2a. *Path b* represents the effect of procedural fairness (M) on election legitimacy, the dependent variable (Y). These are the tests of H1b and H2b. *Path ab* represents the indirect or mediated effect in which procedural fairness (M) mediates the relationship between the electronic experimental treatments (T) and election legitimacy (Y). These are the tests of H1c and H2c. *Path c'* represents the direct effect of the treatments (T) on election legitimacy (Y) after controlling for the indirect effect (*path ab*). These are the tests of H1d and H2d. Each path was estimated using OLS regression as implemented in Stata's sgmediation2 command, which uses Sobel-Goodman tests to detect mediation in linear regression models (Mize, n.d).

The results presented in the figure and Appendix B provide no evidence that either electronic poll books (H1a) or biometric identity verification (H2a) are related to perceptions of an election's procedural fairness. For both experiments, the estimates for *path a* are statistically insignificant. Therefore, hypotheses 1a and 2a are not supported. On the other hand, the results provide substantial evidence that perceptions of an election's procedural fairness are related to perceptions of an election's legitimacy. For both experiments, the estimates for *path b* are statistically significant. In the poll book experiment, a 1-point increase in procedural fairness was statistically related to an almost 1-point increase (on a 0 to 10 scale) in election legitimacy (0.816, $p < .001$). In the identity verification experiment, a 1-point increase in procedural fairness was statistically related to a similar increase in election legitimacy (0.807, $p < .001$). Therefore, hypotheses 1b and 2b are supported. Further, the results suggest that procedural fairness does not mediate the relationship between the experimental electronic election technologies and perceived election legitimacy. For both experiments, the estimates for *path ab* are statistically insignificant. Further, Sobel-Goodman mediation tests confirm the lack of a discernible mediated effect (Sobel, Aroian, and Goodman tests ranging between $0.67 < p < .76$) for both experiments. Therefore, hypotheses 1c and 2c are not supported. Finally, the results suggest that electronic poll books statistically reduce, not increase as suggested by H1d, perceptions of an election's legitimacy. The estimate for *path c'* in the poll book experiment is negative and marginally statistically significant (−0.242, $p = .052$). Otherwise, they suggest that biometric identity verification is not meaningfully related to election legitimacy. The estimate for *path c'* in the identification experiment is statistically insignificant. The results for experiment 1 are marginally consequential but in the opposite direction, so hypotheses 1d and 2d are not supported in either experiment. In summary, the results do not support Hypotheses 1/2a, 1/2c, or 1/2d, but they provide substantial support for Hypotheses 1/2b.

Discussion and conclusion

As governments increase their reliance on electronic technology for election administration, this study is designed to test the effects of electronic election systems on election legitimacy. Scholars argue that a lack of legitimacy undermines democracy (e.g., Norris, 2014). Proponents of electronic election systems suggest that these systems make elections cleaner and more credible by reducing human-induced error – accidental error or intentional fraud (Cheeseman et al., 2018). This study tests for effects using two survey experiments that capture the second step in the voting process (Spencer & Markovits, 2010): voter check-in and identity verification. Experiment 1 addresses check-in by testing for the effects of electronic versus paper poll books. Experiment 2 addresses voter-identity verification by testing for the effects of conventional or biometric versus conventional verification.

This study proposed four hypotheses for each experiment, which together suggested a mediated relationship. Specifically, the relationship between electronic election technologies and election legitimacy is mediated by perceptions of procedural fairness. Following that theoretical construction of a mediated relationship (e.g., Baron & Kenny, 1986; Preacher & Hayes, 2004), the results provide no evidence that either electronic poll books (H1a) or biometric identity verification (H2a) are related to perceptions of an election's procedural fairness. That is, hypotheses 1a and 2a are not supported.

The results provide substantial evidence that perceptions of an election's procedural fairness are related to perceptions of an election's legitimacy. That is, hypotheses 1b and 2b are supported. Most important in theoretical terms, the results suggest that procedural fairness does not mediate the relationship between the experimental electronic election technologies and perceived election legitimacy. That is, hypotheses 1c and 2c are not supported. Most important in policy terms, the results suggest that electronic poll books reduce, not increase as suggested by H1d, perceptions of an election's legitimacy. Otherwise, they suggest that biometric identity verification has no impact on perceptions of an election's legitimacy. That is, hypotheses 1d and 2d are not supported.

While the results of both experiments contradict expectations, they present clear and informative stories. Electronic poll books have a negative effect on perceived election legitimacy. Biometric identity verification has a substantively negative but statistically indiscernible effect on perceived election legitimacy. So, how do electronic election systems affect perceptions of election legitimacy?

Several findings of experiment 1 suggest that electronic poll books decrease election legitimacy relative to paper poll books. The effects of the electronic poll book treatment were negative and marginally statistically significant in the unmediated regression model (Table 4) and in the mediation models (Appendix B and Figure 2a). The effect was −0.24 points (out of a 0 to 10 scale). It is worth noting that the effect is also negative in the bivariate regression model (−0.311, Table 3), though it fell just short of marginal statistical significance. In terms of theory, these results are contrary to the expectations that electronic poll books would have a positive effect on perceptions of election legitimacy and that the effect would be mediated by perceptions of procedural fairness.

Regarding poll books, we hypothesized that electronic poll books would lead to perceptions of increased procedural fairness, and perceptions of increased procedural fairness then would lead to perceptions of increased election legitimacy. Electronic poll books, though, did not affect perceptions of procedural fairness (see Figure 2a, *path a* and Appendix B, model 2). Rather, electronic poll books directly affected perceived election legitimacy, even without the benefit of an indirect path through procedural fairness. But why would the effect of electronic poll books on election legitimacy be negative? There are several possible reasons, particularly regarding election tampering and the media coverage it received.

The U.S. Department of Justice appointed a special counsel to investigate potential Russian interference in the 2016 presidential election. The final report, often referred to as the "Mueller Report" (Mueller, 2019), was followed at least "somewhat closely" by 66% of respondents in a March 2019 CBS News Poll (2019) public opinion survey of U.S. adults nationwide. The high-profile report indicated that Russia interfered in at least two ways involving cybersecurity in the 2016 U.S. presidential election: social media influence operations (Francois & Lin, 2021; McCombie, 2020; Yang, 2019) and hacking then disseminating sensitive materials from one of the two major national political parties and its presidential nominee (Lam, 2018; Pope, 2018; Ziegler, 2017). Also, but with less fanfare, the U.S. Senate Select Committee on Intelligence issued a report that Russia gained access to election infrastructure systems in all 50 U.S. states (U.S. Senate Select Committee on Intelligence, 2019). Further, the U.S. Intelligence Community released a report that Russia engaged in "Cyber intrusions into state and local electoral boards" also noting that Russia had been researching U.S. electoral processes and related technology and equipment since at least 2014 (ODNI, 2017; U.S. Senate Select Committee on Intelligence, 2019).

These widely covered reports offer reasonable explanations about why U.S. voters might lack full confidence in electronic election systems, and why the use of electronic poll books may undermine, and not enhance, perceived election legitimacy. Indeed, in a 2019 NBC News survey, 55% of respondents reported that the U.S. government was not doing enough to prevent foreign election interference, and 57% indicated they thought Russia would interfere in the 2020 presidential election (Arenge et al., 2018; see also Pew Research Center, 2018).

The results of experiment 2 hint that biometric voter identification has a negative effect on perceptions of election legitimacy. The estimates of the

effects were always negative (bivariate regression in Table 3, unmediated regression in Table 4, and Appendix B and Figure 2b), but they were always statistically insignificant ($p > .55$). Again, in terms of theory, these results are contrary to the expectations that biometric identity verification would have a positive effect on perceptions of election legitimacy and that the effect would be mediated by perceptions of procedural fairness. However, the consistent effect has noteworthy implications to be discussed later.

Deviations and limitations

The deviations from the PAP are limited. Due to election security restrictions, the researchers did not have access to actual poll books to stage precisely parallel images for experiment 1. The images are similar (see Appendix A), but some readers may conclude that any effect could be the result of differences in the images and not the treatment. While the authors believe the differences are trivial and the results are reliable, readers should draw their own conclusions. Further, the results do not include a bivariate correlation matrix, primarily for reasons of parsimony. The information provides only trivial insight, and post-estimation diagnostics suggest multicollinearity is not a problem.

This study has limitations that are both common to experimental social science (e.g., Shadish et al., 2002) and specific to this study. The subjects participated in an artificial setting – completing a survey that was delivered electronically – which may not fully or accurately capture the effects of the treatments in real life such as would be experienced while actually voting at a polling location. Though it seems unlikely that the subjects would identify the intent of the project – understanding the effects of electronic election systems on election legitimacy – sometimes subjects respond to surveys in ways they think the researchers would like them to. Referred to as a demand effect, this effect can bias the results and reduce external validity. While the survey vendor uses rigorous processes with the intent to collect a representative sample, the subjects self-selected into the project as part of an ongoing panel that regularly completes surveys for compensation, which may undermine their representativeness. It is also worth noting, again, that substantial proportions of subjects failed the manipulation checks. As indicated in the Data and Methods section, though, the study's successful randomization and satisfactory group balance analyses suggest the results are reliable. Besides good scientific practice, for all these reasons these studies should be replicated and expanded.

Potential implications

The results suggest that electronic poll books and biometric identity verification may have a negative effect on perceived election legitimacy. So what? The poll book findings could have several significant implications. Given their growing use, decreased election legitimacy may undermine citizens' willingness to comply with government (Berman et al., 2019) and/or to follow the officials elected to lead. Over the longer term, it could lead to reduced voter turnout (e.g., Birch, 2008) as well as more political polarization and divisiveness if one side believes the other is advantaged by the technology. Generally, decreased election legitimacy may undermine democracy (e.g., Norris, 2014). The biometric identity verification findings are similar. The unconfirmed negative effects suggest this election technology may be less controversial but still be difficult to deliberate on and implement. The findings do not negate the possibility of using e-poll books and biometrics, theoretically. For instance, competing parties may see an opportunity to come together on the technology to improve election security (e.g., Paysafe Group, 2019; Wolf et al., 2017) while also increasing voter convenience (Paysafe Group, 2019). To achieve this, though, stakeholders would likely have to address other concerns such as privacy and data security (Agate et al., 2021; Garnett & James, 2020) as well as financial costs incurred from implementing new technology.

Together, the results reveal the multidimensional nature of public attitudes regarding electronic election systems. These attitudes are not uniform; they are complex. The results emphasize the importance of fair procedures but suggest that electronic election systems do not consistently affect perceptions of procedures. They also suggest that the effects of electronic election systems on perceptions of election legitimacy are negative. Different components of the electoral process, when digitized or modernized, may generate different reactions. This suggests that

proposed policies regarding the introduction or modification of any electronic election system should be treated as a unique change, warranting separate investigation and public engagement. The varying attitudes underscore the importance of satisfying the public on the functionality, security, and reliability of any new electronic process or system.

Notes

1. See items ID7, ID12, ID13, ID14, ID15, and ID16 in Appendix A, noting that ID13 and ID15 are reverse coded and that the legitimacy score is the mean of the six items.
2. See items ID1, ID2, ID3, ID4, ID5, ID6, ID8, ID9, ID10, and ID11 in Appendix A, noting that ID1, ID2, ID4, ID6, ID8, and ID9 are reverse coded and that the procedural fairness score is the mean of the 10 items.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The work was supported by the National Science Foundation [2131538].

Notes on contributors

Gregg R. Murray, PhD is a Professor of Political Science at Augusta University. His research focuses on political behavior, particularly voting behavior. His research has appeared in journals such as Political Psychology, Journal of Peace Research, Political Research Quarterly, American Politics Research, Social Influence, and Public Opinion Quarterly. He is editor-in-chief of Politics and the Life Sciences.

Craig Douglas Albert, PhD is a Professor of Political Science and the Graduate Director of the PhD in Intelligence, Defense, and Cybersecurity Policy and of the Master of Arts in Intelligence and Security Studies at Augusta University. His areas of concentration include international security studies, cybersecurity policy, information warfare/influence operations/ propaganda, ethnic conflict, cyberterrorism and cyberwar, and political philosophy. He is widely published, including articles in: Cyber Defense Review; Global Society; Defense and Security Analysis; Intelligence and National Security; Politics; East European Politics; Chicago-Kent Law Review; Social Media + Society; Journal of Political Science Education; Politics & the Life Sciences; Journal of Cyber Policy; Digital War and he has published in cyber-related professional association journals in the area of propaganda and social media warfare, including IEEE proceedings.

References

Agate, V., De Paola, A., Ferraro, P., Lo Re, G., & Morana, M. (2021). SecureBallot: A secure open-source e-voting system. *Journal of Network and Computer Applications*, *191*(October), 103165. https://doi.org/10.1016/j.jnca.2021.103165

Alim, M. A., Baig, M. M., Mehboob, S., & Naseem, I. (2017). Method for secure electronic voting system: Face recognition based approach. In *2nd international workshop on pattern recognition* (pp. 104430H). SPIE. https://doi.org/10.1117/12.2280495

Anderson, C. J., Blais, A., Bowler, S., Donovan, T., & Listhaug, O. (Eds.). (2005). *Losers' consent: Elections and democratic legitimacy*. OUP Oxford.

Arenge, A., Lapinski, J., & Perry, S. (2018). *Poll: Most Americans think Russia will interfere again in 2018 elections*. NBC NEWS. https://www.nbcnews.com/politics/politics-news/poll-most-americans-think-russia-will-interfere-again-2018-elections-n845076

Atkeson, L. R., Bryant, L. A., Hall, T. E., Saunders, K., & Alvarez, M. (2010). A new barrier to participation: Heterogeneous application of voter identification policies. *Electoral Studies*, *29*(1), 66–73. https://doi.org/10.1016/j.electstud.2009.08.001

Banducci, S. A., & Karp, J. A. (2003). How elections change the way citizens view the political system: Campaigns, media effects and electoral outcomes in comparative perspective. *British Journal of Political Science*, *33*(3), 443–467. https://doi.org/10.1017/S000712340300019X

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality & Social Psychology*, *51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Barreto, M. A., Nuño, S., Sanchez, G. R., & Walker, H. L. (2019). The racial implications of voter identification laws in America. *American Politics Research*, *47*(2), 238–249. https://doi.org/10.1177/1532673X18810012

Berman, E., Callen, M., Gibson, C. C., Long, J. D., & Rezaee, A. (2019). Election fairness and government legitimacy in Afghanistan. *Journal of Economic Behavior and Organization*, *168*, 292–317. https://doi.org/10.1016/j.jebo.2019.10.011

Birch, S. (2008). Electoral institutions and popular confidence in electoral processes: A cross-national analysis. *Electoral Studies*, *27*(2), 305–320. https://doi.org/10.1016/j.electstud.2008.01.005

CBS News Poll. (2019, March 25–26). N=1, 002 adults nationwide. Margin of error ± 4. *Polling Report.Com*. https://www.cbsnews.com/news/mueller-report-majorities-across-party-lines-want-full-report-released-says-cbs-news-poll/

Cheeseman, N., Lynch, G., & Willis, J. (2018). Digital dilemmas: The unintended consequences of election technology. *Democratization*, *25*(8), 1397–1418. https://doi.org/10.1080/13510347.2018.1470165

Debos, M. (2021). Biometrics and the disciplining of democracy: Technology, electoral politics, and liberal interventionism in Chad. *Democratization*, *28*(8), 1406–1422. https://doi.org/10.1080/13510347.2021.1907349

Deepika, J., Kalaiselvi, S., Mahalakshmi, S., & Shifani, S. A. (2017, March). Smart electronic voting system based on biometrie identification-survey. *2017 Third International Conference on Science Technology Engineering & Management* (ICONSTEM), Jjeppiaar Engineering College, Tamil Nadu, India (pp. 939–942). IEEE.

Desmarais, M., Michel, L., Russell, A., & Shvartsman, A. (2015). Developing requirements for electronic poll book systems: The distributed systems view and challenges. *National Conference on State Certification Testing of Voting Systems*, Seattle, WA, USA.

Effah, J., & Debrah, E. (2018). Biometric technology for voter identification: The experience in Ghana. *The Information Society*, *34*(2), 104–113. https://doi.org/10.1080/01972243.2017.1414720

Elklit, J., & Reynolds, A. (2002). The impact of election administration on the legitimacy of emerging democracies: A new comparative politics research agenda. *Commonwealth & Comparative Politics*, *40*(2), 86–119. https://doi.org/10.1080/713999584

Endres, K., & Panagopoulos, C. (2021). Photo identification laws and perceptions of electoral fraud. *Research & Politics*, *8*(3), 20531680211030435. https://doi.org/10.1177/20531680211030435

Francois, C., & Lin, H. (2021). The strategic surprise of Russian information operations on social media in 2016 in the United States: Mapping a blind spot. *Journal of Cyber Policy*, *6*(1), 9–30. https://doi.org/10.1080/23738871.2021.1950196

Garnett, H. A., & James, T. S. (2020). Cyber elections in the digital age: Threats and opportunities of technology for electoral integrity. *Election Law Journal*, *19*(2), 111–126. https://doi.org/10.1089/elj.2020.0633

Grimes, M. (2006). Organizing consent: The role of procedural fairness in political trust and compliance. *European Journal of Political Research*, *45*(2), 285–315. https://doi.org/10.1111/j.1475-6765.2006.00299.x

Hubler, K. O. (2014, August). Electronic poll books. *LegisBrief*, *22*(32). National Conference of State Legislatures. https://www.ncsl.org/research/elections-and-campaigns/electronic-poll-books-lb.aspx

Lam, C. (2018). Closing the regulatory gap for synthetic nicotine products. *Boston College Law Review*, *59*(6), Article 7.1933–1982. https://doi.org/10.1056/NEJMp1707409?query=featured_home

Larsen, E. (2018, December 2). *FACT CHECK: Do millions of Americans not have government photo ID? Check your fact*. https://checkyourfact.com/2018/12/02/fact-check-millions-government-photo-id/

Lenz, G. S., & Sahn, A. (2021). Achieving statistical significance with control variables and without transparency. *Political Analysis*, *29*(3), 356–369. https://doi.org/10.1017/pan.2020.31

Lipset, S. M. (1960). Political man: The social bases of politics. In R. Dahl, I. Shapiro, & J. A. Cheibub (Eds.), *The Democracy Sourcebook* (p. 56).

Magalhães, P., & Abril, T. (2018). Favourable outcomes, procedural fairness, and political support: Results from a survey experiment. In M. C. Lobo, F. C. da Silva, & J. P. Zúquete (Eds.), *Changing societies: legacies and challenges. Vol. 2. Citizenship in crisis* (pp. 73–86). Imprensa de Ciências Sociais.

Mazo, E. D. (2019). Finding common ground on voter ID laws. *The University of Memphis Law Review*, *49*(4), 1233–1273. https://www.proquest.com/scholarly-journals/finding-common-ground-on-voter-id-laws/docview/2250568791/se-2

McCombie, S. (2020). The US 2016 presidential election & Russia's troll farms. *Intelligence and National Security*, *35*(1), 95–114. https://doi.org/10.1080/02684527.2019.1673940

Megalingam, R. K., Rudravaram, G., Devisetty, V. K., Asandi, D., Kotaprolu, S. S., & Gedela, V. V. (2022). Voter ID card and fingerprint-based E-voting system. In S. Smys, V. E. Balas, & R. Palanisamy (Eds.), *Inventive computation and information technologies. Lecture notes in networks and systems* (pp. 89–105). Springer. https://doi.org/10.1007/978-981-16-6723-7_8

Merrill, D. W. (2015). *Connecticut electronic poll book system: Requirement specification V1. 0*. Office of the Secretary of the State.

MIT Election Data + Science Lab. (2022). *Voting technology*. https://electionlab.mit.edu/research/voting-technology

Mize, T. D. (n.d.). *Sgmediation2: Sobel-Goodman tests of mediation*. https://www.trentonmize.com/software/sgmediation2

Mondak, J. J. (1993). Institutional legitimacy and procedural justice: Reexamining the question of causality. *Law & Society Review*, *27*(3), 599–608. https://doi.org/10.2307/3054106

Montgomery, J. M., Nyhan, B., & Torres, M. (2018). How conditioning on posttreatment variables can ruin your experiment and what to do about it. *American Journal of Political Science*, *62*(3), 760–775. https://doi.org/10.1111/ajps.12357

Moynihan, D. (2004). Building secure elections: E-Voting, security, and systems theory. *Public Administration Review*, *64*(5), 515–528. https://doi.org/10.1111/j.1540-6210.2004.00400.x

Mueller, R. S., III. (2019). *Report on the investigation into Russian interference in the 2016 presidential election*. https://apps.npr.org/documents/document.html?id=5955997-Muellerreport

National Conference of State Legislatures (NCSL). (n.d). *Electronic poll books*. Retrieved from https://www.ncsl.org/elections-and-campaigns/electronic-poll-books

Norris, P. (2014). *Why electoral integrity matters*. Cambridge University Press.

Office of the Director of National Intelligence. (2017). *Background to "assessing Russian activities and intentions in recent US elections": The analytic process and cyber incident attribution*. https://www.scribd.com/document/335885580/Unclassified-version-of-intelligence-report-on-Russian-hacking-during-the-2016-election#

Paysafe Group. (2019). Lost in transaction: The end of risk? Will biometrics replace passwords for online payment authentication in 2019? *Whitepaper*. https://www.paysafe.com/en/lost-in-transaction-the-end-of-risk/

Pew Research Center. (2018, October 29). *Elections in America: Concerns over security, divisions over expanding access to voting - section 2, figure 1*.

Pope, A. E. (2018). Cyber-securing our elections. *Journal of Cyber Policy*, *3*(1), 24–38. https://doi.org/10.1080/23738871.2018.1473887

Popoveniuc, S., Kelsey, J., & Leontie, E. (2011). On the privacy threats of electronic poll books. *Proceedings of the International Conference on Security and Cryptography*, Seville, Spain (pp. 281–286).

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods Instruments & Computers*, *36*(4), 717–731. https://doi.org/10.3758/BF03206553

Quesenbery, W., Baumeister, L., & Dawkins, S. (2023). Usability and accessibility of electronic pollbooks. *NIST Voting Technology Series: NIST VTS*. https://doi.org/10.6028/NIST.VTS.100-3pt1

Ryan, P. Y. A., Schneider, S., & Teague, V. (2015). End-to-end verifiability in voting systems: From theory to practice. *IEEE Security & Privacy*, *13*(3), 59–62.

Schwarzmann, A. A. (2021). Towards a robust distributed framework for election-day voter check-in. In C. Johnen, E. M. Schiller, & S. Schmid (Eds.), *Stabilization, Safety, and Security of Distributed Systems: 23rd International Symposium, SSS 2021* (pp. 173–193). Springer International Publishing. https://doi.org/10.1007/978-3-030-91081-5_12

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin.

Spencer, D. M., & Markovits, Z. S. (2010). Long lines at polling stations? Observations from an election day field study. *Election Law Journal*, *9*(1), 3–17. https://doi.org/10.1089/elj.2009.0046

Tyler, T. R. (1988). What is procedural justice-criteria used by citizens to assess the fairness of legal procedures. *Law & Society Review*, *22*(1), 103–136. https://doi.org/10.2307/3053563

Tyler, T. R. (1990). *Why people obey the law*. Yale University Press.

Tyler, T. R. (2003). Procedural justice, legitimacy, and the effective rule of law. *Crime and Justice*, *30*, 283–357. https://doi.org/10.1086/652233

Tyler, T. R., & Huo, Y. J. (2002). *Trust in the law: Encouraging public cooperation with the police and courts*. Russell-Sage Foundation.

U.S. Senate Select Committee on Intelligence. (2019). *Report of the select committee on intelligence: United states senate on Russian active measures campaigns and interference in the 2016 U.S. Election volume, 1: Russian efforts against election infrastructure with additional views*. https://www.intelligence.senate.gov/sites/default/files/documents/Report_Volume1.pdf

van der Eijk, C., & Rose, J. (2021). Winner–loser effects in contentious constitutional referenda: Perceptions of procedural fairness and the Brexit referendum. *British Journal of Politics and International Relations*, *23*(1), 104–120. https://doi.org/10.1177/1369148120932852

Varney, C. A. (2009). Procedural fairness. *13th Annual Competition Conference of the International Bar Association*. Antitrust Division United States Department of Justice.

Verified Voting. (2022). *The verifier - poll books - November 2020 and the verifier - poll books - November 2022*. https://verifiedvoting.org/verifier/#mode/navigate/map/ppEquip/mapType/normal/year/2022

Weatherford, M. S. (1992). Measuring political legitimacy. *The American Political Science Review*, *86*(1), 149–166. https://doi.org/10.2307/1964021

Weber, M. (1921/1978). *Economy and society: An outline of interpretive sociology* (Vol. 2). University of California Press.

Wolf, P., Alim, A., Kasaro, B., Namugera, P., Saneem, M., & Zorigt, T. (2017). *Introducing biometric technology in elections*. International Institute for Democracy and Electoral Assistance (International IDEA).

Yang, A. (2019). Reflexive control and cognitive vulnerability in the 2016 U.S. Presidential election. *Journal of Information Warfare*, *18*(3), 99–122.

Ziegler, C. E. (2017). International dimensions of electoral processes: Russia, the USA, and the 2016 elections. *International Politics*, *55*(5), 557–574. https://doi.org/10.1057/s41311-017-0113-1