DEMOGRAPHIC DIFFERENCES IN ATTITUDES TOWARD REMOTE ELECTRONIC VOTING SYSTEMS

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ABSTRACT

Web- and telephone-based remote electronic voting systems (REVS) offer a solution to the problems of manual counting, counting accuracy, timeliness of reporting results and reducing the inconvenience of voting. However, while access to telephones is ubiquitous, the unequal use and access to Internet technology across different demographic groups in the voting population is of concern. We sampled four different populations (college students, technologically-savvy parents, registered voters, and confirmed actual voters) to investigate if attitudes toward a REVS differ across age, race, income, employment status, education, and gender. We found that age was the only characteristic that unambiguously affected the preference of using a REVS over traditional booth voting, and the likelihood of using a REVS. Younger citizens were more likely to prefer an REVS. We also found that regardless of demographic category, most voters indicated a preference for using a Web-based over a telephone-based REVS.

Keywords: remote electronic voting systems, demographics, digital divide, e-government, e-democracy

INTRODUCTION

The controversy surrounding the Florida vote count for the 2000 presidential election in the United States provides a rich impetus for electronic voting research. Voting equipment problems resulted in thousands of unmarked, uncounted and spoiled ballots. Florida is not the only state that has experienced problems with traditional voting techniques. Even in the 2004 election, miscounting problems still existed with many voting machines (2).

A related election concern is the low rate of voter participation. The participation rate in US presidential elections decreased from 63% in 1960 to 51% in 2000 (11). While apathy may be partially responsible for the decline in voter participation, the inconvenience of traditional voting mechanisms also plays a significant role. For example, in the November 2000 US presidential election, 31.1% of registered voters who did not vote said they did not vote due to scheduling conflicts including being out of town (4). Absentee voting is one way to help overcome such schedule conflicts. Since 1978, when absentee voting began in California, the state has experienced a 20% increase in voter participation (24). This increase was primarily due to the increased mobility and flexibility that absentee voting provides. In 2000, Oregon conducted its presidential voting solely by postal mail. Turn out was up 3.5 percent compared with 1996, slightly higher than the national increase of 2.1 percent (2). Unfortunately, most absentee voting requires advanced planning in order to take advantage of it so will not be useful in helping voters with last minute or unanticipated scheduling conflicts.

Remote electronic voting systems (REVSs) offer another solution to improving voter participation by improving voting convenience. An REVS is an entirely automatic electronic voting environment that enables remote voting; eliminates manual registration verification; facilitates monitoring, voting and tallying; and gives immediate and accurate results. While there are systems problems in elections administration that cannot be resolved by any voting technology, such as errors in the registration database, REVS offer a solution to some of the technical limitations of currently prevalent technologies.

The debate about the pros and cons of remote electronic voting is considerable, with concerns about security, feasibility, the voting process, voter participation, and the final turnout (2, 21, 22, 25, 29). Despite many technical challenges and concerns about the feasibility of electronic voting, several states (8, 21, 25, 26), and the US government, e.g. Secure Electronic Registration and Voting Experiment – SERVE (10) are pursuing electronic voting mechanisms. Brazil has already held an all electronic national election (27), and the United Kingdom is pursuing electronic voting for national elections in an attempt to increase voter participation (10).

In general, the social issues surrounding electronic voting include both political (1) and human behavioral issues (22). In this paper, we focus on behavioral issues by examining attitudes toward REVS. By "attitude," we mean people's perceptions, inclinations or disinclinations, beliefs, and preconceptions towards the use of REVS and toward voting in general; by "behavior" we mean people's actual actions taken in the context of REVS and voting in general. Using $\chi 2$ tests of cross-tabulations, multiple analysis of variance, and t-tests of mean differences, we test if attitudes toward REVS differ across pertinent demographic characteristics: age, race, income, employment status, education, and gender. This examination can help us better understand what kind of people would be more likely to prefer REVS technology and would be more likely to use an REVS when REVS become available. Such a study is valuable in helping policy makers better understand the impact of implementing REVS on different segments of the voting population and to determine if there are significant demographic differences in REVS preference (inclination or disinclination)

and use that could harm the democratic process rather than help improve it.

We begin the paper with a description of voting technologies, both traditional and remote electronic, describing the World Wide Web and touch-tone telephone varieties of REVS (6). We then briefly review the literature on the effects of demographic characteristics on REVS use, and we present relevant hypotheses. Next, we describe four studies that survey different targeted samples for their attitudes toward REVS, and we report the results of several analyses that test our hypotheses. Finally, we discuss our findings and conclude with some implications for policy makers involved with the decision of REVS implementation.

VOTING SYSTEMS

Traditional Booth Voting

There are generally five different technologies used for traditional booth voting (2). The first three use paper ballots: hand-counted paper ballots, punch cards, and optically-scanned paper ballots. Although they are the most widely used technology (26), punch card machines result in the most "residual" votes—uncounted ballots, unmarked ballots (where voters did not make any choice) and spoiled ballots (where voters marked more than one name) (2). Residual votes were the principal problem in the 2000 Florida election (30). All paper-based methods require extensive efforts in counting and tallying and are subject to problems with accuracy and timeliness in publishing the results.

The fourth booth technology uses a machine where mechanical levers are used to vote. The fifth technology uses a direct recording electronic (DRE) machine, where voters use physical buttons or touch-screen technology to record choices (similar to ATMs technology). Both of these voting machines can directly record and tabulate ballots without human intervention with the machine. However, since the machines record every ballot directly, officials are limited in their ability to audit the election. If voters misunderstand the instructions and push the wrong buttons, officials have no way to detect or correct these mistakes.

In spite of their shortcomings, voting precincts in the United States use a variety of these five voting technologies. Currently, 2.3% of precincts use hand-counted paper ballots, 28.4% use punch cards, 31.3% use optical scanners, 16.9% use lever machines and 15.4% use DREs (9)—5.9% use more than one system in different locations.

Remote Electronic Voting Systems

Currently, two principal mechanisms are suitable for remote electronic voting. A telephone-based REVS is an interactive voice response system. It uses either touch-tone or voice-activated telephone technology for voting. The voting process is similar to accessing a checking account by telephone. A Web-based REVS operates on the World Wide Web, enabling voting on a designated website. The voting process is similar to accessing a checking account online.

In 2000, more than 51% of U.S. households had one or more computers at home and about 41.5% of these (approximately 20% of all households) could access the Internet (3). However, telephones reach 94% of U.S. households (28). As a result, telephone-based REVS might be more accessible than Web-based systems.

REVS provide potential benefits for government and organizations. REVS can improve voter registration validation and ballot counting accuracy (16). Even though an REVS requires a large initial investment to set up—expenses would include purchasing servers, establishing infrastructure, ensuring security, and training users—long-run cost savings and social benefits can be realized. An REVS could help remove the burden of renting facilities and reducing staff hired during elections. By providing citizens a convenient electoral process, an REVS could attract more voters and improve the participation rate.

For individuals, the most obvious advantage of an REVS is that voting would be convenient and available for 24 hours a day throughout the designated election period. Voters who are busy with work or other responsibilities could vote at their convenience. Moreover, citizens would save time that would have otherwise been spent commuting to a voting location and waiting in line to vote—the latter being a common complaint in the 2000 and 2004 U.S. national elections. This could save money, natural resources and help reduce traffic pollution.

DEMOGRAPHIC DIFFERENCES

Although REVS have significant advantages, one serious accusation against REVS is the notion of the "digital divide." Critics argue that the appearance and use of Internet-based voting technologies present a new form of discrimination against minority voters (25). In particular, they argue that wealthy, highly educated citizens would have disproportionate access to an REVS. Such discrimination in the voting process could threaten the cornerstone of a democratic government: equal representation. Concern about accessibility and disparate impacts on the voting population has led to the criticism that widespread use of REVS may work to the advantage of some political parties or candidates at the expense of others.

Although we cannot attempt here a comprehensive literature review of the effects of demographic characteristics on the use and adoption of computer-based systems in general, it is important to note a few key studies that have identified or discussed important differences. Many studies have suggested that the demographic characteristics of individuals, such as age, education, and income, are highly correlated with their use of the Internet (5, 7, 13, 15). These differences may contribute to a digital divide and to information inequality (14).

By analyzing data collected from three phases of the CommerceNet/Nielsen Internet Demographic Study (Spring 1997, Fall 1997, Spring 1998), Hoffman and Novak (14, 15) found that as income and education levels increase, Internet usage significantly increases. However, they found that the differential adoption among races (specifically Whites and African Americans in the United States) was significant beyond what could be explained by differences in income and education. Similarly, the U.S. Department of Commerce argued, "The digital divide has turned into a 'racial ravine' when one looks at access among households of different racial and ethnic origins" (23).

There has been mixed evidence concerning whether men and women also show differences in adoption of new technical skills. While some studies found gender differences in perception of needed technical systems analysis skills (20), others argue that the role of gender has diminished with the increased ubiquity of computers (17).

A few studies assessed demographic differences associated with the first use of online voting, which occurred in Arizona in 2000 (8, 30, 31). Solop (31) surveyed registered Arizona Democrats before and after the election, assessing their demographic characteristics and interest in online voting. He found that age, income and education greatly influenced whether

or not a respondent actually used the Internet to vote in that election. However, no race effect was found. In that study, about 30% of the respondents indicated that they would be more willing to vote in an election if Internet voting were an option.

Solop (30) surveyed voters who participated in the Democratic Party primary election in 2000, to determine if a voter's demographic subgroup influenced the choice of voting mechanism (the Internet or a traditional method such as booth voting or mail). He found that age, income and education significantly influenced voting method choice. Education was more important than income, and income was more influential than age. Specifically, Internet voting was more appealing to well-educated voters, voters with higher incomes, and younger voters. However, race and gender were not significant factors in determining whether voters chose to use the Internet. Solop (30) also found that where voters lived (urban or suburban) did not affect their decision to vote using the Internet. By assessing voters' attitudes toward using the Internet to vote, he confirmed that the availability of Internet voting could encourage a significant number of people that might otherwise not have participated to vote in an election. In his study, 17% of registered Democrats said that they would be likely to vote if Internet voting were available.

Done (8) randomly surveyed 495 Arizona residents immediately after the online 2000 election. His study confirmed Solop's finding that increases in income or education increased the likelihood of Internet voting. However, a majority of respondents in all ethnic, education and income groups indicated their willingness to vote by the Internet. Moreover, of the survey respondents who did not register for the 2000 national election, 62% indicated they would be willing to register using the Internet. These results indicated that using the Internet to vote would increase participation across all age, gender, education and income groups, which contradicts Mohen and Glidden's (21) argument that Internet voting would not influence voter participation.

These studies provide a good start in investigating demographic differences in attitudes toward an REVS. However, the studies we have cited are all associated with Arizona's first online election, and only assess citizens' attitudes toward Web-based voting. Telephone-based REVS is also an option worthy of consideration, especially considering that telephones are far more available to the public than are Internet-connected computers. In this paper, we test a series of hypotheses based on the effects of demographic characteristics on preference of using an REVS over traditional booth voting, and preference of an Internet- versus telephone-based REVS. Specifically, we offer hypotheses based on age, race, income level, employment status, level of education, and gender.

H1: Younger citizens are more likely to prefer an REVS than older ones.

Young people generally are more likely to use newer technologies such as the Internet, and newer applications of older technologies, such as using telephones for accessing bank accounts than older people. Computers are an integral part of the curriculum of many high schools and universities in the United States. Thus, growing up in an environment increasingly saturated with new technologies, we expect the younger generation to be more likely to use new applications such as an REVS. Our expectations are consistent with Solop's findings (30).

H2: Race will not have a significant effect on preference for using an REVS.

Based on Solop's (30, 31) findings, we expect that race will not affect voting mechanism preference.

H3: Citizens with higher incomes are more likely to prefer an REVS than those with lower incomes.

Individuals with higher incomes are more likely to own the technologies necessary (computers and Internet access) to take advantage of an REVS and therefore more likely to use them. This is consistent with the findings of Solop (30) and Done (8).

H4: Students and employees (full-time or part-time) of voting age are more likely to prefer an REVS than those with other employment statuses.

Students of voting age are typically university students or high school seniors. We argue that students and employed citizens are more likely to have easy access to the Internet through connections at school or work. Thus, we would expect them to be more comfortable using it for a wide variety of applications, including Internet voting.

H5: Better-educated citizens are more likely to prefer an REVS than those with less education.

In general, we would expect that better-educated citizens are more likely to be comfortable users of newer technologies, particularly the Internet. Although many citizens with higher levels of education might not have learned to use the Internet and other advanced technologies while they were in school, higher education generally generates an appreciation for technology and increases the likelihood that a person would be open to learning how to use new technologies. This is consistent with the findings of Solop (30) and Done (8).

H6: Gender will not have a significant effect on preference for using an REVS.

Based on Solop's findings (30, 31), we expect that gender will not affect voting mechanism preference. A recent study on ERP systems also revealed that no gender differences exist regarding the user's satisfaction toward new technical systems (32).

H7: Web-based REVS will be preferred over telephone-based REVS.

The only major implementation of an REVS for a public election used a Web-based system (30). Moreover, we would expect that the graphical interface of the Web would be preferred over the more limited voice- or touch-tone-driven interface of a telephone, among all the demographic groups.

RESEARCH METHODOLOGY

To better understand differences in attitudes toward REVS usage across various demographic variables, we conducted four separate studies, using multiple analysis techniques. We collected data from four very different populations to gain in-depth knowledge about REVS attitudes between different groups. Our first two studies targeted populations primarily composed of people we believe are most likely to use an REVS. This is important, in addition to a random sample of voters, to highlight the most pertinent issues to address for actual potential users. Otherwise, an REVS might be designed according to the opinions of "the average voter," whose opinions might be different from those who are genuinely interested in using an REVS. Thus, it is important to verify if this is indeed the case by sampling such populations. In the first study, we surveyed students at a major state university and in the second we surveyed the parents of students at a technologically-advanced high school. Based on our literature review, we would expect that a sample of students and of adults with high incomes and high education would be most likely to maximize any effects of voting mechanism preferences, if such effects indeed exist (8, 30). Solop's (30) study found that among Arizona Democrats, young men, people with high income, high education are more inclined to use vote online. Third, we studied a very random

population of registered voters, emphasizing randomness and representativeness of the larger population. Finally, we studied a population of confirmed voters in order to examine attitudes of people who actually do vote, rather than those who merely indicate an intention to vote. Table 1 displays the demographic characteristics of each of our four samples.

TABLE 1
National Voter Demographics Compared to Four Targeted Samples

	USA Nov. 2000 Reported voted (thousands)		Total in our Survey		Students		Parents		Registered Voters		Confirmed Voters	
Age	**110,826**		**551**		**138**		**117**		**92**		**204**	
18 to 24	8,635	7.8%	135	24.5%	112	81.2%	0	0.0%	5	5.4%	18	8.8%
25 to 44	40,738	36.8%	177	32.1%	22	15.9%	48	41.0%	37	40.2%	70	34.3%
45 to 64	39,301	35.5%	205	37.2%	4	2.9%	68	58.1%	44	47.8%	89	43.6%
65 and older	22,152	20.0%	34	6.2%	0	0.0%	1	0.9%	6	6.5%	27	13.2%
Race	**110,826**		**549**		**138**		**117**		**90**		**204**	
Asian	2,045	1.8%	28	5.1%	21	15.2%	1	0.9%	2	2.2%	4	2.0%
Black	12,749	11.5%	64	11.7%	18	13.0%	6	5.1%	25	27.8%	15	7.4%
White	89,469	80.7%	444	80.9%	93	67.4%	109	93.2%	60	66.7%	182	89.2%
Others	6,563	5.9%	13	2.4%	6	4.3%	1	0.9%	3	3.3%	3	1.5%
Income (our survey)			**547**		**138**		**117**		**88**		**204**	
Under $20,000			34	6.2%	27	19.6%	1	0.9%	6	6.8%	0	0.0%
$20,001 to $30,000			56	10.2%	12	8.7%	1	0.9%	12	13.6%	31	15.2%
$30,001 to $60,000			109	19.9%	28	20.3%	10	8.5%	25	28.4%	46	22.5%
$60,001 to $90,000			144	26.3%	31	22.5%	20	17.1%	28	31.8%	65	31.9%
Above $90,000			204	37.3%	40	29.0%	85	72.6%	17	19.3%	62	30.4%
Income (USA)	**86,443**											
Under $25,000	11,173	12.9%										
$25,001 to $35,000	9,026	10.4%										
$35,001 to $50,000	12,853	14.9%										
$50,001 to $75,000	18,341	21.2%										
Above $75,000	25,060	29.0%										
Not reported	9,990	11.6%										
Employment Status			**548**		**138**		**116**		**90**		**204**	
Work full-time			292	53.3%	19	13.8%	69	59.5%	67	74.4%	137	67.2%
Homemaker			43	7.8%	0	0.0%	27	23.3%	4	4.4%	12	5.9%
Work part-time			54	9.9%	27	19.6%	14	12.1%	3	3.3%	10	4.9%
Student			97	17.7%	86	62.3%	0	0.0%	0	0.0%	11	5.4%
Retired			44	80%	0	0.0%	4	3.4%	9	10.0%	31	15.2%
Other			18	3.3%	6	4.3%	2	1.7%	7	7.8%	3	1.5%
Education	**110,826**		**551**		**138**		**116**		**93**		**204**	
Less than high school	10,212	9.2%	5	0.9%	0	0.0%	0	0.0%	4	4.3%	1	0.5%
High school graduate	32,749	29.5%	67	12.2%	22	15.9%	2	1.7%	24	25.8%	19	9.3%
Some college	33,339	30.1%	173	31.4%	89	64.5%	12	10.3%	23	24.7%	49	24.0%
Bachelor's degree	22,661	20.4%	191	34.7%	24	17.4%	51	44.0%	25	26.9%	91	44.6%
Advanced degree	11,865	10.7%	115	20.9%	3	2.2%	51	44.0%	17	18.3%	44	21.6%
Gender	**110,826**		**552**		**138**		**117**		**93**		**204**	
Female	59,284	53.5%	280	50.7%	52	37.7%	82	70.1%	50	53.8%	96	47.1%
Male	51,542	46.5%	272	49.3%	86	62.3%	35	29.9%	43	46.2%	108	52.9%

In each of these four studies, we conducted three different types of data analysis. The first analysis cross-tabulated the respondents based on their preference for voting mechanisms and on their demographic characteristics. We conducted chi-square tests to determine if the demographic characteristics affected voting mechanism preference. The following demographics were examined: age group, race, income level, employment status, highest education, and gender. Based on the response to their voting mechanisms preference, we grouped respondents into one of four voting intention categories. For this analysis, we made no distinction between preferences for Web- or telephone-based REVS. The four categories are:

1. Non-voter: Those who have no intention of voting regardless of available mechanisms;
2. Booth only: Those who intend to vote, but would use a traditional booth even if an REVS were available;
3. Prefer REVS: Those who intend to vote regardless of available voting mechanism, but would prefer to use an REVS if available; and
4. REVS only: Those who would vote only if an REVS were available.

We made it clear to respondents that booth voting would always be an option as we believe there will not be any national voting in the next ten years that would use an REVS without a booth voting option.

It turned out that there were too few respondents in any sample classified as non-voters; thus, we never used this category in our chi-square testing. Another problem was that there were often not enough REVS-only respondents. As a result, in some cases we had to include REVS-only respondents with those who prefer an REVS for our chi-square tests. Table 2 displays the number of respondents in each category of voting choice for each of our four partial samples used for this analysis.

The second analysis used MANOVA techniques to assess the impact of demographic characteristics on REVS preference. More specifically, we investigated attitudes toward Web-based and telephone-based REVS across demographic characteristics. For this analysis, the demographic characteristics were the same as those used in the initial cross-tab analysis. Whenever we did not have enough respondents in a demographic group, we combined groups to increase the analysis cell sizes.

TABLE 2
Number of Respondents by Voting Choice and Sample

	Students		Parents		Registered Voters		Confirmed Voters		Total	
Non-voters	7	6%	0	0%	2	3%	6	4%	**15**	**4%**
Booth only	10	9%	34	39%	21	31%	57	39%	**122**	**30%**
Prefer REVS	73	67%	52	59%	43	64%	85	57%	**253**	**61%**
REVS only	19	17%	2	2%	1	1%	0	0%	**22**	**5%**
Total	**109**	**100%**	**88**	**100%**	**67**	**100%**	**148**	**100%**	**412**	**100%**

In the third analysis, we examined REVS type (Web vs. telephone) preference to see if it was dependent on demographic characteristics. Since we hypothesized that respondents would prefer Web-based over telephone-based, we used one-tailed paired t-tests to test these differences. As before, whenever we did not have enough respondents in any demographic group, we combined appropriate groups to meet the cell-size assumptions of the test. Table 3 displays the likelihood of using Web-based and telephone-based REVS by sample. From this data, it seems immediately apparent that more participants would prefer to use a Web-based REVS than a telephone-based one.

TABLE 3
Likelihood of Using a Web- or Telephone-based REVS by Sample

		Students		Parents		Registered Voters		Confirmed Voters		Total	
Very Unlikely	**Web**	13	9%	25	21%	19	20%	44	22%	**101**	**18%**
	Phone	19	14%	22	19%	19	20%	51	25%	**111**	**20%**
Unlikely	**Web**	6	4%	15	13%	11	12%	26	13%	**58**	**10%**
	Phone	18	13%	19	16%	10	11%	36	18%	**83**	**15%**
Neutral	**Web**	17	12%	12	10%	11	12%	27	13%	**67**	**12%**
	Phone	30	22%	21	18%	16	17%	36	18%	**103**	**19%**
Likely	**Web**	25	18%	33	28%	26	28%	48	24%	**132**	**24%**
	Phone	31	22%	28	24%	25	27%	41	20%	**125**	**23%**
Very Likely	**Web**	77	56%	33	28%	27	29%	59	29%	**196**	**35%**
	Phone	40	29%	28	24%	24	26%	40	20%	**132**	**24%**
Total	**Web**	**138**	**100%**	**118**	**100%**	**94**	**100%**	**204**	**100%**	**554**	**100%**
	Phone	**138**	**100%**	**118**	**100%**	**94**	**100%**	**204**	**100%**	**554**	**100%**

Study 1: Likely Users of REVS: Students

For the first two studies, we selected a group of respondents whom we believe would be highly likely to use an REVS. Such a focus is important in order to maximize the effect sizes of our instrument measurements. In other words, we sought respondents among whom, if we would ever find any significant effects of attitudes toward REVS anywhere, we would most likely find them there. For this purpose, we collected data from two sub-groups: undergraduate and graduate students at a major state university, and parents of the students at a private high school. In this section, we describe our study of students. The students are a very young block of voters, and they are currently being educated in an environment where the Internet is widely used. Table 1 describes the demographics of these students, while Table 4 displays the test results.

Because our population consists of college students, the sample is heavily skewed toward younger ages, as would be expected. There is a large representation of minority races, constituting 32.6% of the sample. Although our income categories are different from those of the national statistics, the income distribution seems quite similar to the national numbers. As would be expected, the education level is heavily skewed toward those with some college education (64.5%), and no one in this sample has less than a high school diploma. The gender distribution of this particular sample features a disproportionate number of males, comprising 62.3%. Not surprisingly, 62.3% of the students indicated "Student" for their employment situation. The 33.3% who selected "Working full-time" or "Working part-time" are also students, but these respondents apparently identify more with their work than with their student status.

Our first statistical analysis involved testing to see if any demographic categorizations affected our respondents' preferences between voting with booths versus REVS ($\chi 2$ tests of cross-tabulations). Table 2 displays the number of respondents in each category. The significance of difference at cross-tabulations test is presented in the last column of Table 4. In this first study, we had 109 students. Because of the small number of non-voters, we excluded them from our group analysis; that is, we analyzed 102 students across three categories (booth only, prefer REVS, and REVS only).

Next, we conducted MANOVA to assess students' likelihood of using an REVS (whether Web- or telephone-based) across different demographic characteristics. In order to assure the validity of the results, we combined similar groups as necessary to ensure the minimum cell size of 20. We had 138 valid observations of students after we deleted five observations that had too many missing values. Finally, using paired t-tests, we further examined students' preference between Web- and telephone-based REVS across various demographic characteristics.

Study 2: Likely Users of REVS: Parents

For the second study, as in the first, we selected a group of respondents whom we believe would be highly likely to use an REVS. After selecting undergraduate and graduate university students, we next selected a sample of parents of the students at a private high school. The United States Department of Education has twice cited the high school we selected as a National School of Excellence. The parents of these students are relatively well educated and have relatively high incomes. Table 1 describes the demographics of these parents, while Table 5 displays the test results. As with the students in the first study, among this sample we would expect to detect any effects of REVS attitudes that we might seek, if such effects actually exist.

TABLE 4
Statistical Analyses for Students

	t-test of Web vs. Phone				ANOVA			X^2
	#	Web	Phone	Sig. t	MANOVA	Web	Phone	
		Means (1 to 5)			P values			
Age		Younger students referred web to phone, older students relatively indifferent			No significant difference			18-24 preferred REVS more than 25-64
18 to 24	112	4.13	3.41	0.000	0.952	0.783	0.887	0.018
25 to 64	26	3.81	3.35	0.127				
Race		All preferred web to phone			Whites preferred REVS more than all other minorities together. However, when six "Hispanics and Others" were excluded, no significant differences found.			No sig. difference
White	93	4.23	3.57	0.000	0.070	0.038	0.036	0.487
Minority	45	3.73	3.04	0.001				
Income		All preferred web to phone			No significant difference			No sig. difference
Under $30,000	28	3.97	3.23	0.000	0.823	0.825	0.426	0.764
$30,001 to $60,000	38	4.04	3.43	0.006				
$60,001 to $90,000	51	4.26	3.74	0.005				
Above $90,000	25	4.03	3.28	0.000				
Employment Situation		All preferred web to phone			Working students preferred telephone voting more than non-working students. No significant difference on Web voting. However, working students are older than non-working ones; this employment effect probably has more to do with age.			Working students preferred REVS more than non-working.
"Student"	86	3.83	3.00	0.000	0.047	0.073	0.014	0.006
Full/part-time	46	4.24	3.62	0.000				
Education		All preferred web to phone			No significant difference			Lower-educated students preferred more than higher-educated
High school graduate	22	4.18	3.55	0.006	0.502	0.211	0.633	0.015
Some college	89	4.16	3.43	0.000				
Bachelor or above	27	3.67	3.19	0.008				
Gender		All preferred web to phone			Females prefer telephone more, but no significant difference with Web			No sig. difference
Female	52	4.15	3.75	0.003	0.036	0.538	0.020	0.235
Male	86	4.01	3.19	0.000				

In the subgroup of parents, we kept about 118 respondents after conducting missing data analysis. Because our population consists of the parents of high school-age students, all except one of our respondents is aged between 25 and 64. Because of the unique characteristics of the particular school we chose for the sample, the parents are very homogenous regarding race, with 93.2% being White. With only four minorities out of 88 valid results, we were unable to test for any race differences in this sample. This is an upper-class school, so the income levels and education levels are extremely high, with 72.6% having family incomes over $90,000 and 87.9% with a bachelor's degree or higher. 59.5% of the parents work full-time, 23.3% are homemakers, and 12.1% work part-time. 70.1% of the respondents are female. We had the middle and high school children send one survey home to be completed by one parent only, and apparently mothers were more likely to complete the survey than fathers were.

First, we tested if any demographic categorizations affected our respondents' voting intentions ($\chi 2$ tests of cross-tabulations). Table 2 displays the number of respondents in each category. We had 88 parents whom we analyzed across three categories (booth only, prefer REVS, and REVS only). Next we conducted MANOVA to assess parents' likelihood of using an REVS (whether Web- or telephone-based) across different demographic characteristics. We had 118 valid observations of parents after we deleted five observations with too many missing values. In this group, as expected, most parents are well-educated with relatively high incomes. Finally, after

investigating preferences of REVS in general, we used paired t-tests to further examine parents' preferences for specific mechanisms of REVS (Web- and telephone-based) among various demographic characteristics.

TABLE 5
Statistical Analyses for Parents

	t-test of Web vs. Phone				ANOVA			X^2
	#	Web	Phone	Sig. t	MANOVA	Web	Phone	
		Means (1 to 5)			P values			
Age		No significant difference			No significant difference			No sig. difference
25 to 44	48	3.23	3.17	0.336	0.442	0.267	0.831	0.831
45 to 64	68	3.31	3.21	0.079				
Race								
Black	6	N/A			N/A			N/A
Asian	1							
White	109							
Hispanic or Others	1							
Income		All preferred web to phone			No significant difference			No sig. difference
Under $90,001	30	3.27	3.17	0.270	0.817	0.756	0.560	0.961
Above $90,000	85	3.28	3.14	0.079				
Employment Situation		Workers preferred web to phone; homemakers relatively indifferent			No significant difference			No sig. difference
Working full/part-time	83	3.34	3.16	0.014	0.084	0.508	0.513	0.936
Homemaker	27	3.11	3.37	0.141				
Education		Those with advanced degrees preferred web to phone; others relatively indifferent			No significant difference			No sig. difference
Bachelor or lower	63	3.19	3.206	0.447	0.251	0.622	0.590	0.692
Master or above	51	3.33	3.06	0.017				
Gender		No significant difference			No significant difference			No sig. difference
Female	82	3.34	3.28	0.278	0.417	0.583	0.250	0.579
Male	35	3.17	2.94	0.066				

Study 3: Registered Voters

After examining two groups of citizens who would be very likely to use REVS, we obtained a sample that was better representative of the general population. We surveyed citizens who had been selected for jury duty. The county-level court calls jurors from a random sample of registered voters; thus, this sample is particularly generalizable to the voting public. We surveyed 99 citizens from a number of juror panels. After deleting four observations with too many missing values, we obtained a sample size of 95. Table 1 displays the demographic distribution of this random sample of registered voters, while Table 6 displays the test results.

The age distribution of the registered voters in our sample was fairly comparable to national voters statistics, except that we had 6.5% of respondents over age 64, compared to 20.0% nationally. Our sample had a large representation of minority races, constituting 33.3%. While this was different from national figures, a large number of minorities is valuable for testing race-based differences in our analyses. It is difficult to compare income distributions since we used different income categories from the US Census Bureau. However, the two largest groups in this sample were $30,001 to $60,000 (28.4%) and $60,001 to $90,000 (31.8%). However, the education level of our sample was quite similar to national figures, though our sample was slightly better educated than the national averages. The gender distribution is virtually identical with national numbers, with 53.8% female and 46.2% male. The two largest employment groups in our sample were full-time workers (74.4%) and retired citizens (10.0%).

First, we tested for demographic categorizations that might affect voting intentions ($\chi 2$ tests of cross-tabulations). We had 67 unambiguous responses among registered voters. Table 2 displays the number of respondents in each category. Since we had only two non-voters and one who would only use an REVS, we excluded these categories from our group analysis; that is, we analyzed 64 registered voters across two categories (booth only and prefer REVS). Next, we conducted MANOVA to assess the likelihood that the registered voters would use an REVS (whether Web- or telephone-based) across different demographic characteristics. We had 95 valid observations of registered voters after we deleted four observations with too many missing values. Finally, we used paired t-tests to examine registered voters' preferences between Web-based and telephone-based REVS across demographic characteristics.

Study 4: Confirmed Voters

In the previous studies we have described, we sampled and questioned citizens based on their eligibility to vote and on the assumption that they might possibly do so. However, many who intend to vote end up not doing so. In order to obtain perspectives from citizens who do indeed vote, we also surveyed voters as they walked out of the polling stations on Election Day in 2002. Thus, we personally confirmed that the respondents for this final study actually voted in a recent national election. We collected 219 questionnaires. After assessing the missing values, the eventual sample size for this study was 205. Table 1 describes the demographics of this sample of confirmed voters, while Table 7 displays the test results.

TABLE 6
Statistical Analyses for Registered Voters

	t-test of Web vs. Phone				ANOVA			X^2
	#	Web	Phone	Sig. t	MANOVA	Web	Phone	
		Means (1 to 5)			P values			
Age		No significant difference			No significant difference			No sig. difference
18 to 44	42	3.50	3.29	0.110	0.717	0.726	0.805	0.783
Above 44	50	3.24	3.22	0.454				
Race		No significant difference			No significant difference			No sig. difference
White	60	3.33	3.13	0.235	0.773	0.922	0.551	0.196
Minority	30	3.37	3.33	0.405				
Income		No significant difference			No significant difference			No sig. difference
$20,001 to $60,000	37	3.24	3.16	0.386	0.877	0.608	0.757	0.566
Above $60,000	45	3.42	3.27	0.090				
Employment Situation		No significant difference			No significant difference			No sig. difference
Working full/part-time	70	3.30	3.21	0.203	0.740	0.523	0.448	0.182
Others	20	3.55	3.50	0.429				
Education		No significant difference			No significant difference			No sig. difference
High school or less	28	3.39	3.4286	0.362	0.900	0.858	0.620	0.720
Some college or associate	23	3.43	3.35	0.216				
Bachelor or above	42	3.24	3.10	0.295				
Gender		No significant difference			No significant difference			No sig. difference
Female	50	3.60	3.42	0.152	0.186	0.067	0.255	0.285
Male	43	3.02	3.07	0.400				

The age distribution of the confirmed voters in our sample was quite similar to national voters statistics, except that we had 13.2% of respondents over age 64, compared to 20.0% nationally. The racial make-up of the voting precincts from which we were able to collect data resulted in a sample with 89.2% White voters. The residents of these precincts were somewhat more affluent and better educated than average, thus 62.3% had family incomes over $60,000 and 66.2% had a bachelor's degree or higher. The gender distribution is fairly even, with 47.1% female and 52.9% male. The two largest employment groups in our sample were those working full-time (67.2%) and retired citizens (15.2%).

First, we tested for demographic categorizations that might affect voting intentions ($\chi 2$ tests of cross-tabulations). In this study, we had 148 unambiguous responses among verified voters. Table 2 displays the number of respondents in each category. Not surprisingly, none of the voters indicated that they would only vote in the future if an REVS were available—everyone in this study had just finished voting in a booth. What is surprising is that six of them indicated that they were unlikely to vote in the next national election. We examined the questionnaires of these six respondents, but could not find any explanation for their unwillingness to vote in future elections. They were evenly spread across all demographic categories. Even though all six had voted more than five times in the past, they all indicated that they were "unlikely" or "very unlikely" to vote using any means—whether traditional booth voting or an REVS. None of these six respondents left any comments that might help explain their responses. We excluded these respondents from this analysis only; that is, we analyzed 142 voters across two categories (booth only and prefer REVS).

Next, we conducted MANOVA to assess the likelihood that the confirmed voters would use an REVS (whether Web- or telephone-based) across different demographic characteristics. We had 204 valid observations of registered voters after we deleted 15 observations with too many missing values. Finally, we used paired t-tests to examine confirmed voters' preferences between Web- and telephone-based REVS across demographic characteristics.

DISCUSSION OF RESULTS

In this paper, we have reported the findings for the analyses of citizens' preferences regarding REVS across four different samples that represent different relevant populations of potential REVS users. Here we consolidate and discuss these findings.

Preference between Voting with Booths versus REVS ($\chi 2$ tests of cross-tabulations)

First, we comment on our findings on preferences between voting with booths versus using REVS. In this analysis, we did not distinguish between Web- or telephone-based voting.

- **Age:** The only study in which we found significantly different preferences for booth or REVS voting was for the students ($p=0.018$). It seems that this limited support for H1 is due to the limited variation in ages in our study samples. To verify this explanation, we combined the student sample with the parent sample, and found a highly significant difference ($p<0.001$) in REVS preference due to age, with ages 18-24 strongly preferring REVS to traditional booth voting. Thus, we are confident that the cross-tabulation supports H1.

TABLE 7
Demographics and Statistics of Confirmed Voters

	t-test of Web vs. Phone				ANOVA			X^2
	#	Web	Phone	Sig. t	MANOVA	Web	Phone	
		Means (1 to 5)			P values			
Age		All preferred web to phone			Younger voters more likely to use REVS			No sig. difference
18 to 44	88	3.56	3.22	0.000	0.004	0.014	0.002	0.095
45 to 64	89	3.09	2.88	0.016				
Above 64	27	2.67	2.07	0.005				
Race		All preferred web to phone			Whites significantly less likely to use REVS than minorities. However results skewed by two Asian pro-REVS outliers			Minorities preferred REVS more than whites did
White	182	3.15	2.84	0.001	0.075	0.028	0.034	0.012
Minority	22	3.91	3.55	0.029				
Income		All preferred web to phone			No significant difference			No sig. difference
$20,001 to $30,000	31	3.10	2.77	0.033	0.966	0.938	0.918	0.910
$30,001 to $60,000	46	3.30	2.87	0.001				
$60,001 to $90,000	65	3.28	2.98	0.008				
Above $90,000	62	3.21	2.95	0.024				
Employment Situation		Workers preferred web to phone; retirees indifferent			Workers more likely to use REVS than retired voters			No sig. difference
Working full/part-time	147	3.46	3.13	0.000	0.002	0.003	0.007	0.078
Retired	31	2.58	2.35	0.147				
Education		All preferred web to phone			No significant difference			No sig. difference
High school or less	20	3.10	2.65	0.035	0.950	0.841	0.719	0.844
Some college or Associate	49	3.16	2.86	0.042				
Bachelor	91	3.22	2.92	0.001				
Master or above	44	3.41	3.09	0.002				
Gender		All preferred web to phone			No significant difference			No sig. difference
Female	96	3.17	2.91	0.006	0.677	0.547	0.924	0.917
Male	108	3.30	2.93	0.000				

- **Race:** The student and registered voter studies both show that race has no significant effect on preference of voting mechanism; the parent study has insufficient minorities to conduct a test. The confirmed voter study reveals that minorities significantly preferred REVS (p=0.012). However, with only 1 minority out of 13 in a sample of 142, the $\chi 2$ test is not valid. Thus, this result might very well be spurious, especially considering its inconsistency with the other studies. Overall, we conclude that our findings do not support H2 regarding preferences for voting mechanism.
- **Income:** For all four studies, there is no evidence that income level affects a citizen's preference for voting mechanism, contrary to H3.
- **Employment situation:** The findings for employment situation are not simple to interpret because we compared different groups for each of our four studies. The parent and registered voter studies showed no significant effects of employment situation in voting preferences. For students, those who indicated that they were full-time workers (in addition to being students) tended to prefer traditional booth voting to REVS (p=0.006). This finding supports H4. However, these full-time employed students tend to be older than other students are. It could be that their age, rather than their employment status, was responsible for their preference. In the case of confirmed voters, full-time employed voters marginally preferred (p=0.078) REVS to retired and "other" voters, which finding also supports H4. Again, we easily explain this finding by noting that retired voters are older than other categories, and we have already shown that age is a significant factor. Thus, although our analyses have found some effects of employment situation in support of H4, age readily explains these findings.
- **Education:** The only significant difference due to education occurs among students, where those with less education than a bachelor's degree actually prefer REVS to those with a bachelor's degree or higher (p=0.015). Although this sounds counterintuitive, it is readily explained when we understand that college students with less than a bachelor's degree are those currently enrolled who have not yet graduated. These students are much younger than those who have a bachelor's degree or higher. Again, age explains the only significant finding here. In light of the other studies, we consider this result among students spurious. Thus, we conclude that for our cross-tabulation analysis, education has no effect on preference for REVS mechanism, contradicting H5.
- **Gender:** In no case was there any significant difference between females and males in their preference between

traditional booth voting and REVS. This finding supports H6.

Likelihood of Using an REVS (MANOVA)

Next, we examine the impact of demographic characteristics on citizens' likelihood to use an REVS across four studies. Many of the results are consistent across the four studies.

- **Age**: In general, younger people were more likely to use REVS than older people were (supporting H1). Specifically, people aged 18 to 24 were most likely to use REVS.
- **Race:** The studies of registered voters and parents did not show any significant differences between whites and minorities. For students, the comparison between whites and minorities (Asian, Black, Hispanics and others) showed significant results. However, excluding six Hispanics from the minority group yielded non-significant results. Thus, these particular observations disproportionately influenced the initial significant results. Similarly, among the confirmed voters, some extreme responses among minorities significantly influenced the results. Moreover, the ratio of whites to minorities in this study is much larger than 1.5 to 1; this imbalance in a MANOVA could influence the validity of the results. Therefore, we conclude that there are no significant differences among race groups (supporting H2).
- **Income:** We found no significant differences at all income levels consistently across all four studies (H3 is not supported). This means that total family income did not influence the likelihood that anyone would use an REVS.
- **Employment situation**: Full-time and part-time workers were more willing to use REVS compared to retired people. Moreover, full- and part-time workers who were also students were less willing to use REVS than other students were. On examining the ages of these students, we found that full-time students were younger than those students who worked full- or part-time. We could also see that the average age of full- and part-time workers was lower than that of retired people. Thus, we believe the significant differences between employment situations are actually due to age differences. This is our findings of age effects. In light of this explanation, our analyses only tenuously support H4.
- **Education:** We found no significant differences at all education levels, supporting H5. It is interesting to see that better-educated people were not more likely to use an REVS than those with less education. Many with high school or less education indicated that they were likely to use an REVS. Thus, we did not find the alleged discrimination bias due to education.
- **Gender:** We found no significant differences between females and males in three studies. However, among the students, females seemed more likely to use telephone-based REVS than males. On examining the other findings, we doubt this unusual result could be generalized. In most cases, females and males do not have significant differences in their perceived usage intention of REVS, supporting H6.
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Preference of REVS Mechanism (paired t-tests)

Before implementing an REVS, the government has to decide which mechanism most people would prefer. In these four studies, we compared citizens' preference of REVS mechanism and tested for differences in preferences across demographic groups.

Based on the results from these studies, we found that generally all citizens preferred Web-based REVS to telephone-based, strongly supporting H7. The students had the strongest preference of Web-based over telephone-based REVS. Confirmed voters also had strong preferences for Web-based REVS. Although this preference of Web-based REVS is not significant in the studies of registered voters and parents, the means of Web-based REVS likelihood was consistently higher than the means of telephone-based REVS in almost all demographic categories.

Thus, even though telephones are more available than computers, most people would nonetheless prefer Web-based REVS. We believe this is because of the graphical and interactive features of computers. Computers can provide both video and audio interaction; thus, it is easier for voters to interact with the system and cast their ballots without confusion than if they could only listen to voice prompts. Although our respondents overwhelmingly preferred Web-based REVS to telephone-based, the difference in preference was not statistically significant in some samples. Thus, while Web-based REVS is the preferred mechanism, telephone-based systems are an acceptable alternative.

Overall Findings Regarding Hypotheses

- **Age (H1):** Generally, we found that younger people had higher preferences for REVS than older people did, supporting H1. Specifically, as we have proposed, people at the age group of 18-24 have the highest perceived intentions to use REVS. This is reasonable because the younger generation is widely exposed to new technologies such as the Internet, and thus has relatively higher technical comfort and expertise, which would be conducive to using REVS. However, older people, who generally tend to be slower to change, are more reluctant to use REVS.
- **Race (H2):** Our findings regarding race were inconsistent. While most of our tests indicated that there was no significant difference in REVS preferences due to race, a few tests indicated that whites preferred REVS to minorities, and others that minorities preferred them to whites. We attribute the inconsistencies to the relatively small numbers of minorities in our samples, which violated the cell-size requirements of the $\chi 2$ and MANOVA tests. However, our sample of registered voters was the most balanced regarding race, featuring 33% minorities (28% black). All analyses for this study revealed no significant differences between whites and minorities. Thus, we conclude that our findings support H2, though not unequivocally. Although prior research has supported this conclusion (8, 30, 31), further research might be necessary that targets a sample optimized to maximize race variation.
- **Income (H3):** All analyses in all studies showed that there is no effect of income level on preferences of REVS, failing to lend any support whatsoever to H3. This is understandable because almost 94% of Americans own a telephone at home and more than 50% of households have a home computer (3). Moreover, as the price of computers continually drops, income increasingly becomes even less of an issue.
- **Employment situation (H4):** As we explained earlier, age differences readily explain the only apparent effects of employment situation. The older working students did not

prefer REVS as much as the non-working students, who were generally younger. In the case of confirmed voters, older retired citizens were less enthusiastic towards REVS than younger full- or part-time workers were. Thus, though our findings appear to support H4, age seems to be the driver of students and workers preferring REVS. We cannot conclude that students and full-time workers prefer REVS due to their greater exposure to the technologies, as we had argued when hypothesizing H4. To support this argument, we would need further research that gathers data that would permit controls for age.

- **Education (H5):** We found no significant differences in REVS preference among education levels, with the exception of among students. As we explained earlier, we easily explain this difference by age differences. Thus, we conclude that our results fail to support H5. That is, better-educated people did not prefer REVS more than those with less education did.
- **Gender (H6):** We found no significant differences in REVS preference between females and males in our four studies, with one exception. Among students, females seemed more likely to use telephone-based REVS than males. We cannot readily explain this finding. However, as this was the only significant result among our twelve analyses of gender, we attribute this particular finding to sampling error. Thus, we conclude that our results strongly support H6.
- **Web versus telephone (H7):** Almost universally, our studies showed that citizens either significantly preferred Web-based REVS to telephone-based ones, or that there was no significant difference between their preferences. Even when the difference was not statistically significant, the means almost always indicated a slight preference of the Web over telephones. The only exception was among homemaking parents, who might have preferred telephones to the Web. However, even this finding was non-significant. Thus, we conclude that our findings strongly support H7.

Our present research conducted among four different samples partially confirmed some findings from previous studies, and contradicted others (8, 30, 31). The results of our four studies confirmed that race and gender are not significant factors that affect residents' voting participation by using an REVS. Thus, these studies do not support the speculation about race discrimination in REVS usage. Moreover, our study confirms Solop's (30, 31) finding that younger citizens significantly prefer REVS to senior citizens. Thus, it is feasible for the government to implement REVS in the near future, as the younger generation of voters strongly favors REVS, compared to their parents or grandparents.

However, our findings contradict those of Solop (31) that indicate that income and education are important factors influencing citizens' REVS usage. Although in some of our studies respondents with higher income and higher education levels had a relatively higher intention to use REVS, there were no statistically significant differences across any income or education group. This is in spite of the fact that we specifically chose some better educated and higher income samples, which should have maximized such effects, if they existed. These insignificant results echoed Done's (8) findings among Arizona residents across income and education groups. As we have discussed above, this insignificance could be partially due to the low price of computers and widespread accessibility of telephones. Nonetheless, further research on low income and less educated samples would be worthwhile to strengthen the conclusiveness of these present findings.

As to overall voting participation by using REVS, our present results confirmed Solop (30, 31) and Done's (8) findings that REVS can significantly increase voting participation. For all our studies, a majority of respondents would prefer to use an REVS in an election if it were an option. In particular, Web-based REVS are preferred to other voting mechanisms (telephone-based REVS and booth voting).

CONCLUSION

Today, electronic government is increasingly important in government reform (18, 19). As an important component of e-government, REVS have long been advocated—increasingly so since the paper-ballot debacle of the 2000 election in the United States. However, there have been concerns that these technologies would unfairly aid and favor certain demographic groups. In this paper, we described four studies that conduct multiple analyses on different samples of citizens to understand demographic preferences related to REVS. We studied university students, technology-favoring parents, registered voters, and confirmed voters. For each of these samples we analyzed their preferences of voting mechanism, their likelihood to use an REVS, and their preference between Web- and telephone-based REVS.

Among various demographic categories of age, race, income, employment status, education level, and gender, we found that age was the only characteristic that unambiguously and consistently affected citizens' preference of using an REVS over traditional booth voting, and their likelihood of using an REVS. We also found that regardless of demographic category, virtually all voters either preferred using the Web to telephones for REVS, or they were indifferent to the mechanism used.

These findings have important implications for policy makers who are considering implementing REVS in their jurisdictions. A primary concern and cause for hesitation in implementing REVS has been the fear of unfairly discriminating against certain segments of the population. Race, income, and education level have been the primary characteristics of concern, as these three are the major constituents of socioeconomic status. However, these studies have found that citizens do not differ in their attitudes toward REVS across these characteristics. Employment status and gender have not been as much of a concern, but we have found that these do not matter significantly either.

Age, the only relevant criterion, is not a demographic characteristic for which discrimination has been a particular concern. However, citizens over the age of 64 are significantly more averse to using REVS than are others. This is particularly important when we note that 20% of all voters are in this category. Eliminating booth voting and replacing them with REVS would likely make voting inaccessible to an important percentage of the voting public.

Since we found that our respondents overwhelmingly preferred Web-based REVS to telephone-based, this should be the technology of choice. While our findings imply that policy makers ought to go ahead to implement Web-based REVS for their many benefits, it is imperative that REVS only be provided alongside traditional booth voting. By providing this additional beneficial voting mechanism, policy makers would make it easier for citizens to fulfill their civic duty of building a democratic society.

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