Does State Online Voter Registration Increase Voter Turnout?*

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Objective. The objective of this study is to examine the impact of U.S. state online registration reforms on voter turnout. More states have been adopting online voter registration in recent years. Investigating the impact of the policy on voter turnout can inform policy making and contribute to our knowledge of political behavior. *Methods.* The methods of this study include difference-in-difference analysis and instrumental variable analysis. Using the Current Population Survey data between 2000 and 2014, I conduct a difference-in-difference analysis at the state level and then an instrumental variable analysis at the individual level. *Results.* The results of this study demonstrate that state online voter registration increases voter turnout. The difference-in-difference analysis shows that the states' implementation of online voter registration increases the turnout of young voters by about 3 percentage points in presidential election years. The instrumental variable analysis shows that the usage of online registration by voters increases their turnout by about 18 to 20 percentage points. *Conclusion.* The conclusion of this study is that state online voter registration reforms are generally effective in increasing voter turnout. There are nontrivial positive effects of online registration on turnout, especially for young people during presidential election years.

The rational choice model of voting predicts that a voter registration reform should increase turnout by reducing voting costs (Downs, 1957; Riker and Ordeshook, 1968). While the theoretical expectation that voter registration reforms increasing the convenience of registration will increase turnout is unambiguous, empirical studies show a mixed picture. Previous studies have led to mixed findings for the turnout effects of the "motor voter" law (Rhine, 1995; Knack, 1995; Fitzgerald, 2005; Martinez and Hill, 1999; Brown and Wedeking, 2006; Springer, 2012) but positive turnout effects of same-day registration (Fenster, 1994; Brians and Grofman, 2001; Knack, 2001; Fitzgerald, 2005; Larocca and Klemanski, 2011; Springer, 2012; Neiheisel and Burden, 2012; Burden et al., 2014). Some scholars become skeptical of the turnout effects of state voter registration reforms. For example, Highton (2004:512) commented a decade ago that "there is now little room for enhancing turnout further by making registration easier."

Despite the lack of consistent evidence of turnout effects, state governments have adopted more voter registration reforms recently, including online voter registration. Twenty states implemented online voter registration between 2000 and 2014, the period of this study. This study investigates whether online voter registration reform increases voter turnout. Overall, I find positive effects of online voter registration on turnout. On average, a state increases the turnout of young voters in presidential election years by about 3 percentage points by implementing an online voter registration system. Moreover, the use of online

*Direct correspondence to Jinhai Yu, School of Public Economics and Administration, Shanghai University of Finance and Economics, Shanghai 200433, China ⟨yu.jinhai@mail.shufe.edu.cn.⟩ Jinhai Yu shall share all data and coding for republication purposes. The author thanks Prof. Edward T. Jennings, Jr., Prof. J. S. Butler, Dr. Nate Kratzer, and two anonymous reviewers for their comments and help. The Online Appendix to this study can be accessed at ⟨https://jinhai-yu.com/research/⟩.

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registration by voters increases their probability to vote by about 18 to 20 percentage points. These findings indicate that online voter registration reform is effective in increasing voter turnout. They also represent new evidence supporting the rational choice model of voting (Downs, 1957; Riker and Ordeshook, 1968).

This article makes three contributions to the literature. First, I present the first systematic, empirical investigation of the effects of online registration on turnout. I also explore the heterogeneous effects of online registration on turnout by age of voters. Second, I assess the turnout effect of states' adoption of online registration as well as voters' use of online registration. As a voluntary venue of voter registration, online registration is not used by each voter. It is equally important to understand the turnout effects of actual usage of online registration by voters as that of states' provision of the online registration option. Third, I conduct an instrumental variable analysis by taking advantage of a unique opportunity to match two Current Population Survey (CPS) supplement surveys in 2010 and 2012. This helps address the endogeneity problems when examining the turnout effects of voters' use of online registration.

Voter Registration Reform and Turnout

Online Voter Registration

In 2002, Arizona became the first state to implement an online voter registration system. Online voter registration reforms diffused to other states rapidly in the following decade. In an online voter registration system, voters fill in application forms and submit them to election officials. The election officials validate the submitted information by comparing it against "the information provided by the same individual when he or she received a driver's license or other state-issued identification cards" (National Conference of State Legislatures (NCSL), 2016).

While more states have adopted online voter registration, it remains unclear whether the reform increases voter turnout. Two existing studies related to online voter registration are limited in answering this question. First, in a policy report on the California online voter registration system, McGhee (2014) concluded that it failed to increase voter turnout. The external validity of this study is limited because it focuses on a single state.

Second, in a field experiment, Bennion and Nickerson (2011) find that email outreach for college students to use online voter registration tools makes them less likely to register. They suggest procrastination is the cause in that some students have difficulty in remembering to mail back printed registration forms to registration offices. This proposition of procrastination hinges on the feature of the online registration tool they study, which requires users to download, to complete, and to mail in registration forms. In contrast, state online registration systems allow online submission of registration information, and thus procrastination is less likely to occur. Bennion and Nickerson (2014) conduct a similar experiment to compare the effects on voter registration of emails linking to traditional downloadable forms and the online voter registration system of Indiana. They find that email outreach does not increase voter registration in either case. More importantly, in both experiments, the treatment is not the use of the online registration tool per se but the email reminders to use the tool. Thus, these findings have limited implications for the effects of online registration on voter registration or turnout.

Other Voter Registration Reforms

Except for North Dakota, the voters in all other states who want to vote are required by law to register. The traditional form of registration imposes a substantial cost on voters because they must take a separate trip to register in addition to voting (Rosenstone and Wolfinger, 1978). If registration costs represent one of the barriers to voting, the voter registration reforms that decrease registration costs should increase voter turnout. The "motor voter" law, or the National Voter Registration Act of 1993, requires states to allow voters to register to vote when they apply for or renew their driver's licenses or when they apply for other state and local services, including public assistance and disability benefits. By eliminating the need for a separate physical trip, the "motor voter" law can increase voter turnout. Nonetheless, studies have shown mixed findings on its impacts on turnout. Rhine (1995), Knack (1995), and Fitzgerald (2005) find that state "motor voter" law increases voter turnout. Other scholars, however, find that the "motor voter" law has no effects on turnout (Martinez and Hill, 1999; Brown and Wedeking, 2006; Springer, 2012).

Same-day registration, or election-day registration, allows voters to register on the same day when they vote. Voters have no need to take a separate trip to register. Moreover, the timing of registration is no longer restricted by closing date as under the traditional voter registration. Because same-day registration reduces registration costs, it should increase voter turnout. Indeed, many studies have found a positive impact of same-day registration on voter turnout (Fenster, 1994; Brians and Grofman, 2001; Knack, 2001; Fitzgerald, 2005; Larocca and Klemanski, 2011; Springer, 2012; Neiheisel and Burden, 2012; Burden et al., 2014).

More recently, scholars have examined the turnout effects of preregistration for young voters. By allowing the young to register to vote before reaching 18 years of age, the preregistration reform reduces registration costs by offering more time and flexibility for young people to register. Holbein and Hillygus (2015) find preregistration for young voters increases turnout. This finding is consistent with the proposition that registration reforms reducing registration costs increase voter turnout. In comparison, there has been no systematic empirical study on turnout effects of online voter registration, a new state voter registration reform that reduces registration costs.

Hypotheses

In a rational choice model of voting, voters vote only if the benefits of voting exceed the costs of voting (Downs, 1957; Riker and Ordeshook, 1968). As Rosenstone and Wolfinger (1978:28) pointed out, "the more time and energy required to vote, the lower the possibility that an individual will vote." This implies that the lower the costs of voting become, the higher the possibility that a voter will vote. Since the costs of registration represent a significant part of voting costs, the changes in registration costs can alter voters' calculus of voting. Other things being equal, as the registration costs become lower, voters should be more likely to vote since the total costs of voting are decreased.

Online voter registration reduces registration costs in three ways. First, it may reduce costs for voters because, as under the "motor voter" law and same-day registration, they face no need to take separate trips to register. Second, as compared to the traditional way to register and the "motor voter" law, online registration allows more flexibility in timing and places to register. Voters can register online if they have access to the online registration systems before the due date. Given that state registration reforms allowing for evening and

Saturday registration increase voter turnout (Rosenstone and Wolfinger, 1978), the effect of flexible timing of registration may be nontrivial. Third, online registration provides an additional venue of registration for voters, particularly those who have access to the Internet. By offering more opportunities to register, the reform may reduce registration costs by making it more likely for voters to find a way that suits their needs.

Thus, the rational choice model of voting predicts that online voter registration increases voter turnout by reducing voter registration costs. The main hypothesis to be tested is as follows:

H1: Online voter registration has a positive effect on voter turnout.

Furthermore, the effects of voter registration reforms on turnout may vary by age. Existing studies show that the "motor voter" law has larger impacts on the turnout of young people (Highton and Wolfinger, 1998), especially young women (Parry and Shields, 2001). Scholars also find that same-day registration increases the turnout of young people relative to old people because young people are more likely to use it (Highton, 2004; Knack and White, 2000). Similarly, young people are more likely to use online voter registration because they often have ready access to the Internet and are more accustomed to online political participation (Schlozman, Verba, and Brady, 2010). Online voter registration may have larger positive effects on the turnout of young people than other age groups. Therefore, the second hypothesis follows:

H2: The effect of online voter registration on turnout is larger among younger voters.

Methods

To estimate the effect of online voter registration on turnout, I ask two complementary questions. First, does the adoption of online registration by states increase turnout? This question has direct policy implications for state policymakers because the answer could help them decide whether to adopt online registration. Second, does the use of online registration by voters increase turnout? Presumably, not each voter will choose to register online. Online registration can reduce voting costs only for its users. While the first question assesses the impact of online registration on turnout from the "supply" side, the second question turns to the "demand" side by considering the behavioral responses of voters.

Endogeneity problems exist when answering both questions. First, states' adoption of online registration systems can be endogenous to voter turnout. If citizens and policymakers in a state prefer higher voter turnout, they would choose to adopt online voter registration in the first place. Following previous studies on state voter registration reforms (Ansolabehere and Konisky, 2006; Holbein and Hillygus, 2015), I conduct a difference-in-difference analysis to address the endogeneity problem. The key identification assumption is that, had there been no online voter registration, the states with online registration would have the same trend of turnout as the states without online registration.

Second, voters' usage of online registration is endogenous to turnout because they are not randomly assigned to the option of online registration. A selection problem arises when voters choose whether to register online. Voters with stronger political interests are more likely to vote (Nickerson, 2015), and thus more likely to register online. If political interests are omitted from the model due to difficulty of measurement, the effect of the usage of online registration on turnout would be overestimated. Scholars have employed multiple causal identification strategies to solve this problem, including experiment (Bennion and Nickerson, 2011; Nickerson, 2015), a selection bias model (Timpone,

1998), and regression discontinuity design (Holbein and Hillygus, 2015). I use an instrumental variable analysis. To the extent that the instrumental variables are valid, the instrumental variable analysis should reduce the upward bias by ordinary least squares (OLS) regression.

The instrumental variables are two dummy variables indicating whether voters have access to a computer or the Internet. The two assumptions underlining a valid instrumental variable (IV) are that the IV predicts the endogenous variable and has no direct effect on the outcome variable. In this case, the first assumption is that the voters with access to a computer or the Internet are more likely to choose to register online. The second assumption is that the access to a computer or the Internet is uncorrelated with voter turnout through other ways than online registration.

Both assumptions are plausible. First, voters with access to a computer or the Internet are more likely to register online because they have resources, skills, or habits to do so. To use an online registration system, voters must have computers or other facilities to connect to the Internet. It is more likely for voters owning these resources to register online because they do not need additional investments. In contrast, the voters without a computer or the Internet face higher costs by traveling to such a place as a public library to register online. Furthermore, Best and Krueger (2005) find that Internet skills are positively correlated with online political participation. This implies that voters with Internet skills may be more likely to register online as a form of online political engagement.

Second, voters' access to a computer or the Internet itself does not have direct effects on their turnout. For example, Bimber (2001) finds that access to the Internet has no impact on voter turnout. Moreover, access to the Internet as an IV has been used in previous turnout studies. Tolbert and McNeal (2003) use Internet access as an instrumental variable in examining the impact of consumption of online election news on voter turnout. For their instrument to be valid, it must hold that Internet access does not directly predict voter turnout.

Data and Model

Data

The main data in this article come from the CPS supplemental surveys on voting and registration in every other November between 2000 and 2014. The basic CPS surveys in the same period provide data for individual-level control variables in the model. The CPS data have been used widely in previous studies of voter turnout (e.g., Rosenstone and Wolfinger, 1978; Highton, 1997; Burden et al., 2014; Holbein and Hillygus, 2015). The Census Bureau rotates the CPS sample every four months. Thus, it is impossible to match observations across surveys from every other year at the household or individual level. I create a panel data set at the state level by appending data for each year together. The panel data set is used in the difference-in-difference analysis.

The data for the instrumental variables come from a different CPS supplemental survey. The CPS supplemental surveys on computers and the Internet ask respondents about their accesses to computers and the Internet. While it is impossible to match the CPS supplemental surveys when the time difference between two surveys is 24 months, it becomes possible when the difference is less than 16 months. Most CPS supplemental surveys on voting and registration are conducted in even years. In contrast, most CPS supplemental surveys on computers and the Internet are implemented in odd years. The

only two exceptions occurred in 2010 and 2012, providing a unique opportunity to construct measures for the instrumental variables in this article.

In 2010 and 2012, the CPS supplemental surveys on computers and the Internet were conducted in October, one month earlier than the surveys on voting and registration. Because the time lag between the two surveys is only one month, it is feasible to match them at the individual level. Moreover, the information on computers and the Internet is likely to be relevant for online registration given the short time lag of one month. Under the sample design by the Census Bureau, the upper limit for the matching rate is 75 percent in this case. Using age, race, gender, and two CPS identifiers, I end up with matching 41.64 percent and 40.84 percent for the 2010 sample and 2012 sample, respectively. The nonmatching cases may result from sample nonresponse, mortality, migration, and recording errors (Madrian and Lefgren, 2000).

Two points stand out on how I clean the data. First, since North Dakota has no voter registration requirements, it is irrelevant for this study. I deleted it in the analysis, as did Brians and Grofman (2001). Second, I code the answers in the category of "Not in Universe" as missing. "Not in Universe" means that the question should not be asked for the respondents, as would be the case when asking a labor supply question of a child under 18 (IPUMS-CPS, 2016). Moreover, I recode the answers of "No Response," "Refused," and "Don't Know" as missing. An alternative way is to recode the answers of "No response," "Refused," and "Don't Know" as 0 or merge them into the lowest category when applicable, as in Holbein and Hillygus (2015) and Burden et al. (2014). For example, they assume that the respondents who answer "don't know" to the family income question fall into the lowest family income interval. This assumption may or may not hold. As a robustness check, I recode these answers as 0 and merge them into the lowest category when applicable. I reanalyze all the models and find no material changes in the results.

Model

In both analyses, the dependent variable is a dummy variable *voted*, indicating whether a respondent voted in the November elections. In the difference-in-difference analysis, the independent variable of interest is the dummy variable *online registration*. It equals 1 when a state implements[1] an online voter registration system in a year; and 0 otherwise. Its coefficient shows the effects on their turnout of offering voters the opportunity to register online. If the data support the first hypothesis, the coefficient of *online registration* should be positive.

In the instrumental variable analysis, the independent variable of interest is *registering online*, a dummy variable indicating whether a respondent registered online in a year. Its coefficient shows the effects on turnout when a voter chooses to register online. Similarly, if the first hypothesis receives support from the data, the coefficient of *registering online* should be positive. In the 2010 sample, the instrumental variable is *computer access*, a dummy indicating whether a respondent has access to a computer at home. In the 2012 sample, the instrumental variable is *Internet access*, a dummy showing whether a respondent has access to the Internet.

To test the second hypothesis, the interactions between the key independent variables and the self-reported age of voters are included in both analyses. The coefficients of *online*

[1]Some states enact online voter registration one year but implement it the next year. The variable *online registration* measures the year when online voter registration is implemented.

registration × *age* and *registering online* × *age* will show how the impact of online registration on turnout varies by age of voters. If the second hypothesis stands with the empirical tests, the coefficients should be negative.

In the difference-in-difference analysis, one variable is controlled to account for the variation in implementation of state online voter registration systems. Specifically, while most states require such identity documents (ID) as driver's licenses for citizens to access online registration systems, some do not. Because no ID requirements mean lower registration costs, voters should be more likely to register online to vote. The variable *no ID requirement* is a dummy indicating whether an online registration system has ID requirements. It equals 1 when there are no ID requirements; and 0 otherwise. The coefficient of this variable should be positive.

In addition, I control for both state-level and individual-level variables in the two analyses. Both analyses include five state-level control variables. First, the variable *closing date of registration* is a count of how many days the state voter registration closes before Election Day. The closing dates of most states range from eight days to 30 days before Election Day. If a state allows same-day registration, *closing date of registration* is coded as 0. Larger values of *closing date of registration* mean earlier registration deadlines and less time for voters to register. Thus, the variable *closing date of registration* should have a negative coefficient if earlier closing dates represent one of the barriers of voting.

Second, the variable *same-day registration* is a dummy variable indicating whether a state offers the option of same-day registration in a year. Previous studies (e.g., Burden et al., 2014) consistently show that same-day registration increases voter turnout. Hence, *same-day registration* should have a positive coefficient.

Third, many aggregate-level election studies find closeness of electoral competition increases voter turnout (Geys, 2006). First, the closer the election is, the more likely one voter would influence the election outcome. Second, the closer the election is, the more likely political candidates would increase mobilization or campaign efforts. The variable *closeness of election* is measured by the average percentage of votes held by the winning party in relevant elections in each year. The lower the percentage becomes, the more competitive the election is. Thus, the variable *closeness of election* should have a negative coefficient if more competitive elections induce higher turnout.

Because the CPS supplemental surveys on registration and voting do not ask respondents on which contests on the ballot they voted, it is a necessary compromise to use the average vote shares of the winning party across several elections. In presidential election years, these elections include presidential election, senatorial elections, House of Representative elections,[2] and gubernatorial elections. In nonpresidential election years, the elections include senatorial elections, House of Representative elections, and gubernatorial elections. If any of the elections is absent for a state in a year, it is excluded from the calculation. Thus, the variable *closeness of election* captures the average degree of electoral competition across several elections in each year.

Fourth, as in previous studies (Rosenstone and Wolfinger, 1978; Knack, 1995; Brown and Wedeking, 2006), I control for two dummy variables *senatorial election* and *gubernatorial election* to signify their presence in a state-year. Each dummy variable should have a positive coefficient if voter turnout increases because of the salience of senatorial or gubernatorial elections.

The individual-level control variables are also the same in both analyses. Consistent with previous studies (Holbein and Hillygus, 2015; Burden et al., 2014), I control for

[2]The results are robust with excluding the House of Representatives election (see Table A1.5 in Online Appendix 1).

the individual-level variables including *registered, Department of Motor Vehicles (DMV) registration, time at address, marriage status, business or farm employment, age, female, white, Hispanic, education, metropolitan status, family income,* and *in-person interview*.

In both analyses, the method of estimation is chosen to account for the binary nature of the dependent variables, *voted*. In the difference-in-difference analysis, a probit is used. While probit is preferred, the results of a linear probability model are presented in Online Appendix 1 as a robustness check. In the instrumental variable analysis, both the dependent variable *voted* and the endogenous variable *registering online* are binary. For this case, Wooldridge (2002:594–99) suggests that a bivariate probit is the most appropriate. Specifically, the seemingly unrelated bivariate probit regression is used in the instrumental variable analysis.

The model is specified as follows. First, given the lack of consensus in the literature on whether to control for registration status (e.g., Brians and Grofman, 2001; Holbein and Hillygus, 2015), I estimate the model with and without including registration.[3] Second, studies differ in treating registration and voting as single or separate decisions (e.g., Rosenstone and Wolfinger, 1978; Timpone, 1998). As robustness checks, I model registration and voting both ways. Third, I estimate the model for presidential election years and nonpresidential election years separately, as in Knack (1995).

Results: Difference-in-Difference Analysis

Table 1 shows selected results[4] for the sample of presidential election years. Columns (1), (3), and (5) show the results of probit estimation. The average marginal effects are presented in Columns (2), (4), and (6), respectively. Overall, the findings support the two hypotheses that online registration increases voter turnout and the sizes of effects are larger for young voters.

In Column (1), the dependent variable is a dummy variable *voted* and registration status is ignored. While both *online registration* and *age* have positive and statistically significant effects ($p = 0.1$), their interaction term has negative but statistically insignificant effects. To interpret the marginal effect of *online registration*, one must fix *age* at certain levels. Figure 1 shows the average marginal effects of *online registration* on voter turnout at varying levels of age. Only when the age of voters is around 18 years old, does *online registration* show a positive and statistically significant effect at $p = 0.1$ level. The size of the effect is about 0.03, indicating that when an average state offers citizens the option of online registration, their probability of voting increases by 3 percentage points.

In Column (3), the dependent variable is a dummy variable *registered*. In Column (5), the dependent variable is a dummy variable *voted* conditional on registration. In Columns (3) and (5), the three variables of *online registration*, *age*, and their interaction terms show the same pattern of statistical significance ($p = 0.05$). Figure A1.1 in Online Appendix 1 shows the average marginal effects of online registration on voter registration by age. *Online registration* shows a positive effect on voter registration, but the effect decreases as the age of voters increases. This suggests that online registration increases the likelihood of voter registration more for young voters when online registration becomes available.

Similarly, Figure A1.2 in Online Appendix 1 shows that the impact of online registration on turnout of the voters who have registered is positive and larger for young voters. For

[3]It is feasible to control for registration status only in a linear probability model (see Online Appendix 1).

[4]Results for individual-level controls are omitted; full results are presented in Table A1.1 in Online Appendix 1.

TABLE 1

Effects of Offering Online Registration on Voter Turnout: Probit Estimates (Selected Results)

For Presidential Election Years (2000,2004, 2008, and 2012)

Variables	(1) Voted	(2) Marginal Effect	(3) Registered	(4) Marginal Effect	(5) Voted	(6) Marginal Effect
Online registration	0.140*	0.015	0.248***	0.019***	0.247***	0.037***
	(0.078)	(0.012)	(0.088)	(0.013)	(0.075)	(0.014)
Online registration × Age	−0.002		−0.004***		−0.002**	
	(0.001)		(0.001)		(0.001)	
Age	0.015***	0.004***	0.015***	0.004***	0.014***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
No ID requirement	−0.036	−0.010	0.153***	0.044***	0.089*	0.024*
	(0.038)	(0.011)	(0.040)	(0.011)	(0.050)	(0.013)
Closing date of registration	−0.001	−0.000	−0.002	−0.000	−0.002	−0.001
	(0.001)	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)
Same-day registration	0.011	0.003	0.024	0.007	0.021	0.006
	(0.019)	(0.005)	(0.038)	(0.011)	(0.025)	(0.007)
Closeness of election	−0.468*	−0.135*	−0.028	−0.008	−0.450*	−0.121*
	(0.247)	(0.071)	(0.255)	(0.073)	(0.255)	(0.069)
Senatorial election	−0.025**	−0.007**	−0.029	−0.008	−0.016	−0.004
	(0.012)	(0.004)	(0.018)	(0.005)	(0.012)	(0.003)
Gubernatorial election	0.097	0.028	0.166	0.047	0.059	0.016
	(0.108)	(0.031)	(0.128)	(0.036)	(0.111)	(0.030)
Observations	215,420	215,420	199,099	199,099	202,671	202,671

NOTES: Robust standard errors in parentheses. State and year fixed effects are included. Standard errors are clustered at the state level. In Column (2), DMV registration is omitted because it strongly predicts registration status, the dependent variable in a probit.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

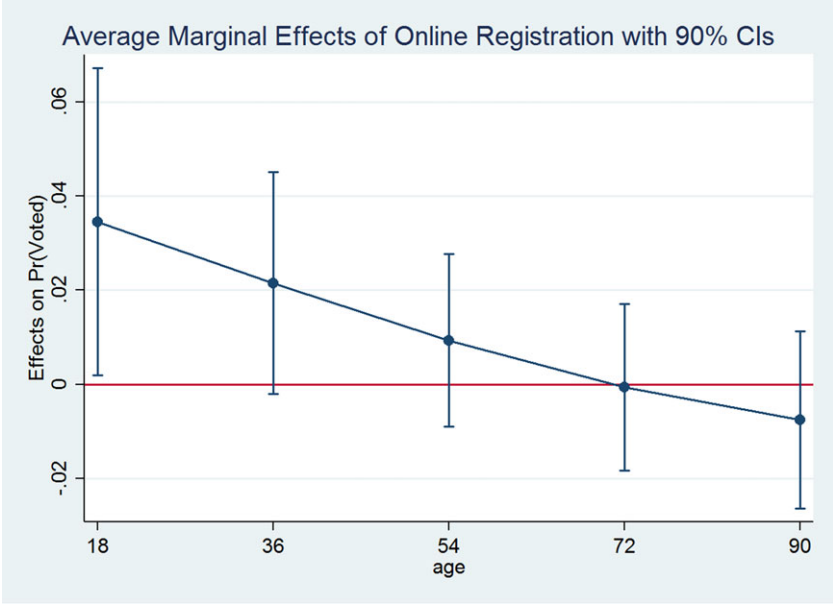
example, for the voters aged 18 years old and having registered, online registration increases their likelihood of voting by about 0.06. This effect is larger than that for the sample without controlling for registration status, as shown in Column (1). Taken together, the results in Columns (3) and (5) imply that online registration increases the turnout of young voters by making it more likely for them to register.

In addition, the no ID requirement, one feature of state online registration systems, seems to matter. In Column (3), the variable *no ID requirement* has a marginal effect of about 0.04, statistically significant at the $p = 0.01$ level. In Column (5), *no ID requirement* has a marginal effect of about 0.02, statistically significant at the $p = 0.1$ level. It seems that, by further lowering registration costs, the elimination of ID requirements for online registration transfers higher likelihood of registration into higher probability of voting conditional on registration.

Two of the five state-level control variables have statistically significant effects on voting. The variable *closeness of election* has negative and statistically significant effects in Columns (1) and (5) at the $p = 0.1$ level. As expected, as the elections get more competitive, more voters vote. The variable *senatorial election* shows a negative and statistically significant effect in Column (1) at the $p = 0.05$ level. This unexpected negative effect may stem from the multicollinearity resulting from the overlap of senatorial elections and presidential elections. Consistent with this interpretation, *senatorial election* turns positive and statistically significant at the $p = 0.01$ level when running the same model for nonpresidential election

FIGURE 1

Average Marginal Effects of Offering Online Registration on Voter Turnout by Age (Presidential Election Years): Probit Estimates



years.[5] Thus, voters are more likely to vote in nonpresidential election years when there are senatorial elections.

In all three model specifications, the individual-level control variables have statistically significant effects on voting, as in existing studies (e.g., Holbein and Hillygus, 2015). White and Hispanic citizens are less likely to vote. In contrast, those who are older, married, more educated, wealthier, live in a metropolitan area, stay at their current address for a longer time, and are employed in business or farming are more likely to vote.

In addition, the same models are estimated for the sample of nonpresidential election years (see Table A1.2 in Online Appendix 1). The key independent variable *online registration* shows no statistically significant effects. Thus, in presidential election years, online registration increases the turnout of young voters but not old voters. In nonpresidential election years, online registration influences the turnout of neither young nor old voters.[6]

Results: Instrumental Variable Analysis

Table 2 shows selected results[7] of OLS regression and bivariate probit regression for the 2010 sample and the 2012 sample. The average marginal effects are presented for each

[5]For full results, see Table A1.2 in Online Appendix 1.

[6]The results are robust when estimated with a linear probability model. For details, see Tables A1.3 and A1.4 in Online Appendix 1.

[7]Results for individual-level controls are omitted; full results are presented in Table A2.1 in Online Appendix 2. Results for the endogenous equations are not reported but available on request.

TABLE 2

Effects of Registering Online on Voter Turnout: IV Estimates (Selected Results)

Variables	(1) OLS 2010	(2) Bivariate Probit 2010	(3) Marginal Effect 2010	(4) OLS 2012	(5) Bivariate Probit 2012	(6) Marginal Effect 2012
Registering online	0.404***	1.306***	0.134**	0.435***	1.863***	0.527***
	(0.064)	(0.251)	(0.059)	(0.036)	(0.234)	(0.052)
Registering online × Age	−0.005***	−0.019***		−0.003***	−0.002	
	(0.002)	(0.005)		(0.001)	(0.005)	
Age	0.004***	0.016***	0.005***	0.002***	0.008***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Closeness of election	−0.106***	−0.364***	−0.114***	−0.584***	−1.896***	−0.565***
	(0.035)	(0.126)	(0.039)	(0.057)	(0.193)	(0.057)
Gubernatorial election	0.013	0.041	0.013	0.082***	0.269***	0.080***
	(0.010)	(0.033)	(0.010)	(0.010)	(0.034)	(0.010)
Senatorial election	0.024***	0.072***	0.022***	0.004	0.014	0.004
	(0.005)	(0.015)	(0.005)	(0.005)	(0.018)	(0.005)
Closing date of registration	−0.001***	−0.002**	−0.001**	−0.001***	−0.003***	−0.001***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
Same-day registration	0.023***	0.065**	0.020**	0.018*	0.081**	0.024**
	(0.008)	(0.030)	(0.009)	(0.010)	(0.034)	(0.010)
Observations	50,044	40,296	40,296	49,599	49,599	49,599

NOTE: For OLS regressions, robust standard errors in parentheses; for bivariate probit regression, bootstrapped standard errors in parentheses.
*$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

bivariate probit model. Overall, the results are consistent with the two hypotheses that online registration increases voter turnout and the effects are larger for young voters.

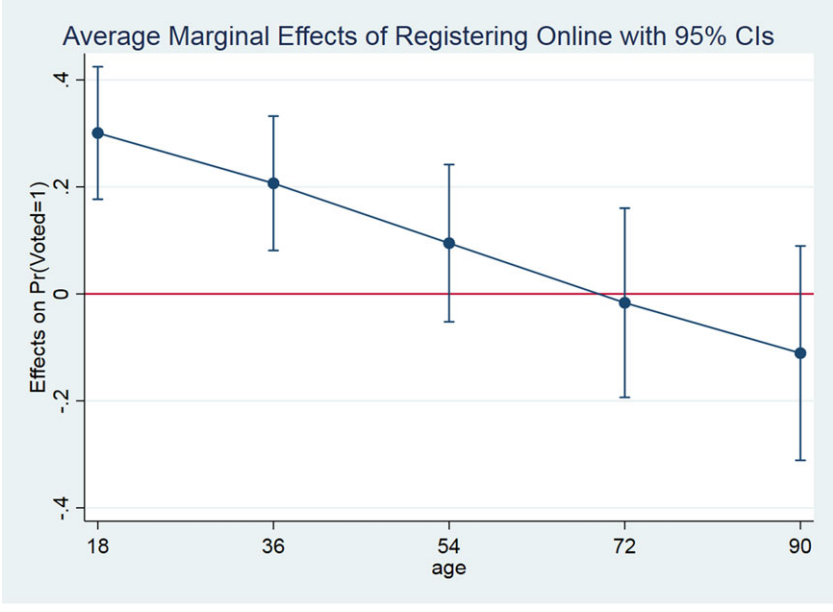
The independent variable of interest, *registering online*, has a positive and statistically significant effect on turnout at the $p = 0.01$ level in all regressions. The interaction terms between *registering online* and *age* have negative signs and reach statistical significance ($p = 0.01$) except for the bivariate probit regression for the 2012 sample. Column (2) shows the results of bivariable probit estimation for the 2010 sample. Using these results, Figure 2 shows the average marginal effects of registering online on voter turnout by age. The positive effects of registering online decrease as the age of voters increases. For example, for an average voter aged 36 years old, the marginal effect of registering online on voter turnout is about 0.2. Thus, registering online increases the likelihood of voting by about 20 percentage points.

As a comparison, Figure A2.1 in Online Appendix 2 shows the average marginal effects of registering online by age of voters based on the results of OLS regression for the 2010 sample. Figure A2.1 shows the pattern as in Figure 2. For an average voter aged 36 years old, the marginal effect of registering online is about 0.23. This effect is larger than the bivariate probit estimate. By treating *registering online* as exogenous, the OLS regression overestimates its effects on turnout. This indicates that the instrumental variable approach corrects the upward bias under the OLS estimation.

Using the bivariate probit results for the 2012 sample, Figure A2.2 in Online Appendix 2 shows the average marginal effects of registering online on voter turnout by age. The pattern remains the same. The positive effects of registering online decline as the age of voters increases. For example, when fixing age at 36 years old, the marginal effect of

FIGURE 2

Average Marginal Effects of Registering Online on Voter Turnout by Age (2010 Sample): IV Estimates



registering online is about 0.56. This is substantially larger than the estimate of 0.2 for the 2010 sample. This may result from the weaker strength of instrumental variable for the 2012 sample. In addition, based on the results of the OLS regression for the 2012 sample, Figure A2.3 in Online Appendix 2 shows a similar pattern. Fixing the age of voters at 36 years old, the marginal effect of registering online is about 0.32, smaller than the corresponding bivariate probit estimate. Given the theoretical expectation that the OLS bias is upward, this should represent an upper bound of the effect, rendering the bivariate probit estimate less credible.

All control variables show expected effects on voter turnout in the bivariate probit regressions, as shown in Columns (2) and (5). The coefficients of individual-level control variables are robust and consistent across the two samples. Compared to the results of difference-in-difference analysis, three more state-level control variables reach statistical significance. The variable *closing date of registration* shows a negative and statistically significant effect ($p = 0.01$), suggesting that earlier closing dates of registration reduce the likelihood of voter turnout. As expected, the variable *same-day registration* shows a positive and statistically significant effect ($p = 0.01$) on turnout. For the 2012 sample, the variable *gubernatorial election* shows a positive and statistically significant effect ($p = 0.01$).

As a robustness check, an alternative instrumental variable analysis is conducted at the state level. The instrumental variable is Internet access measured at the state level, or the percentage of people with access to the Internet from home by state by year. Again, a bivariate probit is estimated. For the presidential election years, registering online shows a positive and statistically significant effect ($p = 0.01$), which decreases as the age of voters increases. For an average voter aged 36 years old, registering online has a marginal effect

of about 0.18. This indicates that registering online increases voter turnout by about 18 percentage points. For nonpresidential election years, *registering online* shows no statistically significant effects. The complete results are provided in Tables A2.2 and A2.3 in Online Appendix 2.

Discussion and Conclusion

I examine the effects of offering online registration to voters and voter usage of online registration on turnout. Overall, I find nontrivial positive effects of online registration on turnout, especially for young people. On one hand, the difference-in-difference analysis shows that the states increase voter turnout by about 3 percentage points by offering the option of online registration. This is true mainly for young voters and during presidential election years. On the other hand, the instrumental variable analysis shows that the turnout of voters increases by about 18 to 20 percentage points when they choose to register online. These sizes of effects of online registration on turnout are comparable with that of preregistration for young voters, another recent state voter registration reform. Holbein and Hillygus (2015) find that state preregistration laws increase turnout of young voters by about 2 to 13 percentage points and the effect changes to 8 percentage points when focusing on the voters who use the preregistration option.

Why does online registration increase turnout mainly for the young voters in presidential election years? First, the differential effects of online registration on turnout by presidential and nonpresidential election years may result from the salience of presidential elections. As voters are more likely to vote in presidential election years than in nonpresidential election years, the advantage of online registration to reduce registration costs may become more appealing to them. This implies that online registration increases turnout by reducing registration costs after the voters have become willing to vote for other reasons, such as salience of presidential elections. Second, the differential effects of online registration on turnout by age may result from the advantage of young voters to register online relative to old voters. As more proficient users of computers and the Internet, young voters are more likely to have the technological knowledge on how to register online. Furthermore, young voters may be more likely to psychologically accept the option of registering online because they have been exposed to similar procedures in electronic commerce.

As more states adopt online voter registration and more voters choose to register online, future studies may find stronger policy impacts on turnout by using more comprehensive and updated data. Furthermore, scholars may examine the distributional effects of online registration on turnout. Beyond heterogeneity by age, future studies may explore the heterogeneous effects of online registration on turnout by income, education, race, and party affiliations.

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