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Note

Reducing the Cost of Voting: An Evaluation of Internet Voting's Effect on Turnout

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Voting models assume that voting costs impact turnout. As turnout declined across advanced democracies, governments enacted reforms designed to reduce costs in order to increase participation. Internet voting, used in elections across a dozen countries, promises to reduce voting costs dramatically. Yet identifying its effect on turnout has proven difficult. In this article, we use original panel data of local elections in Ontario, Canada and fixed effects estimators to estimate internet voting's effect. The results show internet voting can increase turnout by 3.5 percentage points, with larger increases when vote by mail (VBM) is not yet adopted, and greater use when registration is not required. Our estimates suggest that internet voting is unlikely to solve the low turnout crisis, and imply that cost arguments do not fully account for recent turnout declines.

Voter turnout is one of the most widely examined areas of political science. Interest in understanding turnout has only grown as electoral participation has declined in advanced democracies over the past several decades.[1] Low electoral participation calls democracy into question, and undermines government legitimacy, political representation and equitable public policies.[2] To raise participation levels, politicians and administrators often consider electoral reforms, such as compulsory voting or universal voter registration. Differences in electoral rules have been shown to account for variations in turnout across advanced democracies,[3] and some electoral reforms can even affect public policy by changing who participates.[4] But perhaps the simplest and most common electoral reforms aim to reduce voting costs by increasing convenience. Convenience voting options include early voting, extended polling hours and postal voting.[5] These reforms respond to the theory – proposed in basic, rational choice models of voter turnout – that turnout is a function of voting's relative costs and benefits.[6]

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[1] Franklin 1999; Gray and Caul 2000.
[2] Franklin 2004; Teixeira 2011; Wattenberg 2002.
[3] Franklin 2004; Jackman 1987; Powell 1986.
[4] Fowler 2013; Hidalgo 2010.
[5] Gronke et al. 2008.
[6] Aldrich 1993; Downs 1957; Riker and Ordeshook 1968.

In line with these theories, there is some evidence that reducing voting costs can boost turnout.[7] Studies of early voting,[8] extended polling hours[9] and VBM[10] find that these changes affect participation. However, increases in turnout from these convenience reforms are modest, on the order of a few percentage points. These reforms may fail to produce larger results because they do not sufficiently lower voting costs – that is, these voting methods may not be convenient *enough*. Internet voting, wherein citizens can cast ballots remotely through an internet connection, is one of the last possible ways to reduce the transaction costs associated with voting through convenience reforms. Indeed, internet voting reduces the cost of voting to a trivial level – a cost that people bear daily as they check their mail, shop or read news online. In this way, internet voting offers the most stringent test yet of the proposition that the cost of voting significantly impacts turnout.

Relying on this logic, by the early 2000s internet voting was widely regarded as the next possible solution to low turnout. Since the turn of this century, governments around the world have experimented with internet voting in hundreds of binding elections. More than twenty countries have trialed internet ballots, most prominently in Europe, with remote internet voting implemented in fifteen. Currently, internet voting is used in ten countries: Australia, Armenia, France, India, Mexico, Panama, the United States, Estonia, Switzerland and Canada. In the latter three, it has been used for more than a decade and is an established part of the electoral process.

More than fifteen years after initial experimentation, internet voting's effect on voter turnout remains unclear. Governments have often made subjective assessments based on one or two trials, without considering other variables that affect turnout. As extensive research documents, the factors that impact voter participation are complex.[11] Yet, when sharp increases in turnout did not follow internet voting implementation, many programs were canceled. In the United Kingdom, the fact that turnout did not increase in all fourteen districts that used internet voting in 2003 was a primary reason the government terminated a pilot program.[12] Lack of turnout increases was also a factor in program cancellations in Norway and Austria,[13] and postponed adoption in British Columbia, Canada. Clear results on the effect of internet voting on turnout are important as governments and election administrators around the world make decisions about incorporating digital technologies into voting. Although internet voting adoption slowed for a time primarily due to security concerns, unclear impacts on turnout, and shrinking electoral budgets, these reforms are once again being considered.[14]

To date, research examining internet voting and turnout reports mixed findings. Some studies find a null or a small, negative effect.[15] Other research has found positive results, ranging from less than a 3 percentage-point[16] increase to as high as 10 percentage points.[17] Most studies suffer from limits imposed by the way internet voting was implemented in the chosen case, including limited data and research design challenges. We should expect to find clearer results now, since internet voting has been used for more than fifteen years, and internet use has grown dramatically over this time period. We also do not yet understand

[7] Smets and van Ham 2013.

[8] Gronke, Galanes-Rosenbaum, and Miller 2007; Stein and Garcia-Monet 1997.

[9] Wolfinger and Rosenstone 1980; Wolfinger, Highton, and Mullin 2005.

[10] Berinsky, Burns, and Traugott 2001; Karp and Banducci 2000; Southwell 2004; Southwell and Burchett 2000.

[11] Blais 2006; Franklin 2004.

[12] Goodman, Pammett, and DeBardeleben 2010.

[13] Krimmer, Ehringfeld, and Trax 2010.

[14] The Republic of Moldova, for example, plans to trial internet voting in 2018. Generally, the narrative of electoral reform and online voting has been popular in recent years, for example given the Brexit result in the UK and low youth participation. Still, we should not expect internet voting to spread everywhere. In the United States, the California Internet Voting Task Force and the report of the National Workshop on Internet Voting both had a serious chilling effect on the movement toward internet voting, despite the fact that the United States has been a leader in internet expansion and applications in other sectors (Alvarez and Hall 2003).

[15] Bochsler 2010; Germann and Serdiilt 2017; Norris 2004; Segaard, Baldersheim, and Saglie 2013.

[16] Gerlach and Gasser 2009; Trechsel and Vassil 2010; Vassil and Weber 2011.

[17] Solop 2001; Spada et al. 2016.

how context and differences in the design and implementation of internet voting approaches in different jurisdictions may affect turnout results.

This article examines internet voting's affect on turnout using an original fifteen-year panel dataset of local elections in Ontario, Canada. Ontario has the most frequent use of internet voting in elections for this level of government anywhere in the world. The technology was used in four election periods by ninety-eight local governments, for a total of 173 elections. Ontario offers an ideal setting in which to identify internet voting's effect on turnout because the reform was adopted sequentially, over time and space, across numerous binding local elections. Consequently, there were significant over-time changes in the number of municipalities using internet voting – either adopting or stopping use. This allows for a panel dataset with significant variation while providing a good sample size for statistical analysis. Further, internet voting rules, and therefore the cost of voting via the internet, varied across local elections, allowing for an examination of the effects of different policy designs on voting mode choice.

Our article leverages this unique policy adoption pattern to examine how changes in voting costs can affect turnout, identifying the impact of remote internet voting reforms. We find that internet voting has a statistically and substantively significant effect on electoral participation: it is associated with a 3.5-percentage-point increase in voter turnout. Since only 43 per cent of citizens voted in these local, lower-salience elections, this reform raised the size of the voting population by 8 per cent. When internet voting was adopted in places where another convenience voting method – VBM – was not already in place, internet voting's effect was twice as large. We also examined how variation in the costs associated with internet voting affected its use. More people used internet voting when the costs were lower, namely when pre-registration was not required. We find some evidence that more people use internet voting when it is offered both in advance and on election day. Substantively, these results are similar to turnout increases from convenience changes to election rules,[18] experiments aiming to increase turnout[19] and estimated turnout effects from retrospective voting.[20]

Internet voting can increase turnout, but it is not a panacea. While the effect is large enough to potentially change some electoral outcomes, it is not the dramatic change necessary to counter participation declines. More broadly, these findings suggest voting costs are insufficient to explain turnout declines more broadly – even our highest estimates (7 percentage points) for increased turnout cannot explain why the other 50 per cent of citizens still did not vote in these municipal elections. While increasing convenience is an important and relatively simple way to bring some voters back into the process, costs cannot explain overall low turnout in advanced democracies.

INTERNET VOTING IN ONTARIO, CANADA: CONTEXT AND GENERALIZABILITY

There is no perfect case to study internet voting, because the technology was implemented with varying rules, in different places for different lengths of time, often simultaneously with other voting reforms. Still, Ontario's implementation has several useful elements that aid in identifying turnout effects, including significant variation in the reform's timing and rules. To understand how our results may or may not generalize to other jurisdictions, and the way we identify an effect, we first provide background on the Ontario context. Like most advanced democracies, Canada has experienced a decline in turnout over the past twenty-five years. More voters are also casting early ballots, before the election, suggesting that reducing voting costs is important in this context. Rising trends in early voting have occurred in other democracies, such as the United States.[21] Since many countries have seen declining participation and an increased use of advance voting, the Canadian case may be representative.

Internet voting was first used in Canada in 2003 for a federal party leadership vote. Shortly thereafter, twelve Ontario cities and towns adopted it for use in local elections. Since 2003, adoption in Ontario has grown sizably with each election. By 2014, ninety-seven municipalities used the technology, making

[18] Gronke, Galanes-Rosenbaum, and Miller 2008.
[19] Gerber, Green, and Larimer 2008.
[20] Stokes 2016.
[21] Hall 2015.

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internet ballots available to around two million electors. In the forthcoming 2018 elections, more than 150 municipalities have declared their intent to use internet voting, which will make the voting mode available to approximately half of the provincial electorate.[22] Overall, internet voting is popular: in 2014, 63.4 per cent of Ontario voters who lived in areas where it was offered used the internet to vote.

There is evidence that internet voters in Ontario are similar to other convenience voters elsewhere. Research in Canada and Europe shows that internet voters are typically older, wealthier and better educated,[23] which is comparable to results from other convenience voting methods.[24] Voters report the primary motivation for using internet voting is convenience, suggesting the cost of voting is significant to citizens. Along with the socio-demographic profile, this suggests that the voting mode is largely a tool to facilitate voting for the already engaged, in line with the Alvarez and Hall[25] hypothesis. Internet voters in Ontario are likely not that different from internet voters studied in other jurisdictions.

The main benefit the Ontario case provides to analysis is its staggered adoption over time and space. Legislation governing municipal elections in Ontario allows local governments to use alternative voting methods, including internet voting. Beyond the requirement to pass a by-law through the council, communities have autonomy to determine internet voting rules. This independent adoption across municipalities provides significant variation in timing and rules, which helps identify effects. Ontario's internet voting rules varied in two important ways: the time period offered and registration requirements. These same rules are present in other internet voting jurisdictions, allowing for generalizability to other cases. First, most municipalities offered it in advance and on election day. Only allowing citizens to vote in advance, in the period before election day, was rare: six out of ninety-seven municipalities did this. The relatively small uptake of this rule makes it difficult to identify its effects, as we explore in the results section. Secondly, there were differences in the voting process: some communities required registration to vote by internet, whereas others did not. Overall, twelve of ninety-seven municipalities required citizens to register before using internet voting. Unfortunately, we only have data on both of these rules in 2014, the last year internet voting was offered. Still, this allows for some exploration of how rules affect citizens' use of internet voting. We expect both of these rules to reduce turnout.[26]

Different municipalities also offered different voting modes to electors. In some municipalities with resource constraints, paper ballots were eliminated entirely.[27] In 2014, fifty-nine of ninety-eight communities ran local elections without paper ballots. In this way, Ontario diverges from other jurisdictions using internet voting in that many smaller municipalities phased out paper ballots altogether.[28] Relying on internet voting as the only type of ballot could result in a negative impact on

[22] Some of Ontario's larger cities have committed to using internet voting in 2018 including Markham, Greater Sudbury, Burlington and Cambridge.

[23] Goodman 2014; Serdült et al. 2015.

[24] Berinsky 2005. A recent study of Ontario internet voters reports that the average internet voter is 53 years old, has some university education, an annual household income from $80,000 to $99,000, is interested in politics and reports a habitual voting history (Goodman and Pyman 2016). This is slightly older, better educated, wealthier and more interested in politics than paper voters' profiles from the same study. That said, a recent study of all e-enabled elections in Estonia documents that the characteristics of internet and paper voters become more similar over time (Vassil et al. 2016).

[25] Alvarez and Hall 2003.

[26] Although, the variable in the dataset is reversed: it is 1 if there is no registration barrier, 0 if there is a barrier. Thus we expect positive results in our model to suggest that registration barriers decrease turnout.

[27] Some localities' election budgets presented a choice between internet or paper voting, and most chose internet voting because it was less costly, offered electors enhanced voting convenience and provided more efficient tabulation of results. This typically occurred in smaller municipalities with fewer resources.

[28] In addition, remote internet voting was often, but not always, implemented alongside phone voting. However, phone voting is by far the least popular voting method among electors. Of the votes cast in the 2014 election in the twenty-three municipalities that offered all three voting options, 55.6 per cent were cast by internet, 31.6 per cent by paper and 12.8 per cent by phone. Given the low adoption rate, and the fact that our data also include internet-only elections, we do not believe this factor substantially affects the findings' generalizability. In practical terms, phone voting is not that different from internet voting – one is a visual mode while the other is an auditory mode, but both allow for remote voting with common technology.

turnout should a lack of familiarity with computers and the internet deter electors from voting. Further, if internet voting decreases turnout by making voting less public, removing voting booths altogether could amplify decreases in turnout. We expect paper ballot elimination to work against finding a positive effect of internet voting on turnout. In addition, thirty-nine municipalities adopted VBM before internet voting, likely dampening the effect of the newer convenience reform as suggested in other jurisdictions.[29] This context means that the results of implementing internet voting in Ontario may be smaller than we would expect to find in other jurisdictions that have not eliminated paper ballots or which implemented VBM prior to internet voting.

DATA AND RESEARCH DESIGN

This article uses an original panel dataset of five waves of municipal elections, held between 2000 and 2014, to examine whether internet voting adoption changed turnout.[30] These municipal elections typically give citizens the opportunity to elect a mayor, a deputy mayor, councilors, school board officials and other representatives. The sample contains the full population of ninety-eight Ontario municipalities that have used internet voting. In other words, all municipalities in our dataset eventually adopt internet voting, meaning we are estimating a weighted average treatment effect on the treated (ATT).[31] Since internet voting was introduced in 2003, including the 2000 election provides baseline data for all units. Over this time period, 173 out of 490 elections used internet voting.

Variables collected for each local election included voter turnout, internet voting status and electoral competitiveness. The key variable of interest is a binary treatment variable: it is 1 when a municipality is using internet voting in that election year, and 0 otherwise. The benefit of variation in implementation timing is that it allows for a more precise determination of the consequences of internet voting, given time-varying variables such as the election's salience. If it happened to be the case that the treatment – adoption of internet voting – was systematically implemented at the same time as other reforms, we could attribute changes to the treatment erroneously. Our dataset also includes two cases where municipalities stopped using internet voting, creating further identification leverage.[32] Overall, the variation in reform timing, and the rules once implemented, allow for identification of the treatment effect of internet voting on turnout. There is no central repository of local elections data in Ontario. Consequently, data were first obtained from municipalities' official election results and related reports. When data were missing from these sources, municipalities were contacted individually, up to five times. When information was unavailable, local news media were contacted or archives were consulted.[33]

The main threat to this inferential strategy and the effect's generalizability is selection bias in internet voting adoption, which can be thought of as the treatment assignment process. For this reason, it is important to understand when and why Ontario municipalities chose to adopt internet voting. The primary motivation for internet voting adoption was to improve voting accessibility and reduce the costs of voting.[34] Once early adopters reported successful implementation, more cities and towns adopted the reform in subsequent elections: forty-four communities used it in 2010 and

[29] Germann and Serdült 2017.

[30] The election years are: 2000, 2003, 2006, 2010 and 2014.

[31] Fixed-effects estimators estimate a weighted average treatment effect, with more weight given to units with more variation in the treatment. In this case, municipalities that switched in the middle of the period or switched multiple times are given more weight in the model than those that switched at the beginning or the end of the panel, or those that switched only once.

[32] The Township of North Glengarry was an early adopter, implementing internet voting in 2003. It halted use in 2006 because of a preference for paper ballots, but then resumed it again in 2014. The Town of Huntsville used it in 2010 but discontinued adoption due to a technical problem where an overloaded server prevented some electors from casting online ballots.

[33] Although municipalities have a legal obligation to retain election data for seven years, in some cases they fail to do so.

[34] Goodman and Pyman 2016. In related research, early adopter election administrators in Ontario were interviewed. They cited increasing turnout, providing leadership in e-government, accessibility, convenience, citizen-centered service and greater youth involvement as motivations (Pammett and Goodman 2013).

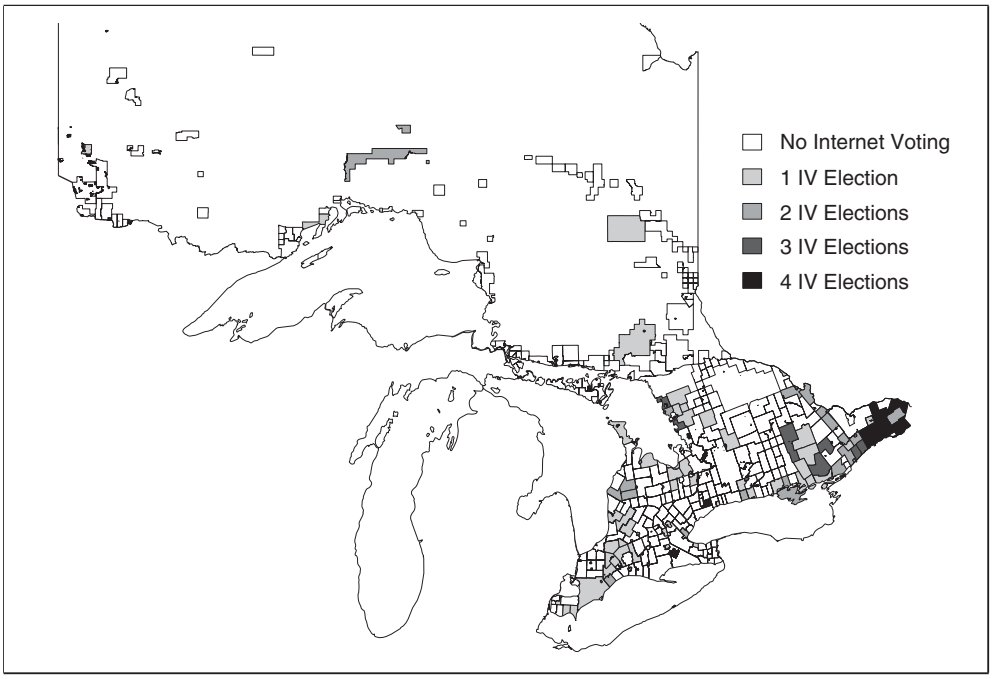

Fig. 1. Municipalities that used internet voting in one to four binding elections
Note: the map also shows the municipalities excluded from the sample that have never used internet voting (white areas).

ninety-seven in 2014. Experience with the technology was shared at municipal conferences, by local associations and through a federal public policy workshop and accompanying report.[35] In these ways, the reform was diffused through municipalities across Ontario largely by bureaucratic policy entrepreneurs (Figure 1).

However, a lack of local political support resulted in some municipalities not adopting internet ballots. Politicians have mixed motives for reform: while they may want to improve voter convenience, they may also be concerned that turnout increases could unseat them. The latter factor could potentially affect which municipalities choose to adopt internet voting, possibly excluding more competitive municipalities. Since we are estimating an ATT and only examining localities that eventually adopted the practice, this concern does not apply to our estimates, but rather, whether our estimates are accurate for municipalities that did not adopt the reform. If politicians are accurate in their predictions, and places with greater potential turnout impacts did not adopt the reform, we should expect that the overall average treatment effect would be somewhat larger than our ATT estimate. Importantly, this was not the primary reason we uncovered for rejecting internet voting; security, cost and electoral integrity concerns were the largest issues.[36] These reasons are less likely than incumbency concerns to lead to a systematic bias in adoption over time and across localities. Further, while not all internet voting proposals passed local councils, the vast majority were accepted. For these reasons, we believe that the ATT we estimate is generalizable, at a minimum to the Canadian context more broadly.

[35] Goodman, Pammett, and DeBardeleben 2010.

[36] For example, in the town of Newmarket, local bureaucrats presented a proposal to use internet voting that the council rejected, citing security concerns and a perception of a lack of public support, based on the results of a resident survey showing 48 per cent of community members in support of internet voting and 46 per cent supporting paper ballots. In the City of Mississauga, the decision not to proceed was due to cost, security and internet voting's perceived ineffectiveness at improving turnout.

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This article relies on fixed effects estimators to estimate the weighted ATT. These estimators control for time-invariant characteristics, such as the average turnout in a given municipality over time. These models include both unit-specific fixed effects at the local, municipal level, and time-period fixed effects for each election year. The basic model specification is given by:

$$Y_{it} = \gamma_i + \delta_t + \alpha D_{it} + \beta X_{it} + \varepsilon_{it} \quad (1)$$

where Y_{it} is the voter turnout in a given municipality, i, in time t; γ_i is the municipality fixed effect; δ_t is the election year fixed effect, α is the treatment effect of internet voting on turnout, and βX_{it} is a matrix of covariate controls. These models assume that $Cov(\varepsilon_{it},D_{it}) = 0$. Given that municipalities adopted internet voting independently, and that they designed their electoral rules with variation across several factors, this should allow us to identify the effect of internet voting on turnout. In the models for Table 3, the dependent variable is the proportion of people voting by internet, and the treatment effect is the various electoral rules.

Time-varying confounders, which are variables that change differentially across units with and without internet voting, can undermine causal inference using fixed-effects estimators. To address potential observable, time-varying confounders, census data were collected and included in some models: population (log), population density (log), unemployment rate, median income (log), population with a university degree (%), population aged 65 or older (%) and immigrant population (%, log).[37] These variables were chosen because they have been shown to predict turnout.[38] To address potential unobservable time-varying confounders, we also examine models with linear unit-specific time trends.

RESULTS AND DISCUSSION

The treatment effect of internet voting on turnout is first estimated using fixed effects estimators with election year and municipal fixed effects (Table 1, Column 1). Given that two municipalities are missing some turnout data, this model relies on a sample size of ninety-six units.[39] We find a statistically significant increase in voter turnout of 3.5 percentage points after internet voting is adopted. Next, we run a model that includes a linear time trend for each municipality. This relatively stringent test does not change the effect size but marginally increases the standard error, as typically occurs (Table 1, Column 2).[40] Our final model includes census variables as controls (Table 1, Column 3). Apart from one variable, a change in these variables is not significantly associated with changes in turnout. Largely, this is understandable given that census variables are slow moving over fifteen years. Including these variables in the model does not change our point estimate or its significance. Overall, our results are robust to these alternative model specifications, suggesting that internet voting's adoption increases turnout by around 3.5 percentage points.

How can we interpret this estimate – is 3.5 percentage points a large or a small result? For comparison, in our dataset moving from an acclaimed mayoral race to the most competitive race possible, in which a candidate wins by one vote, increases turnout by 12.4 percentage points as estimated with a fixed-effects model. By this comparison, the result seems rather large: a quarter of the total additional citizens turning out for the most competitive race imaginable would also vote if they were simply given a more convenient

[37] Census data from Statistics Canada are available in 2001, 2006 and 2010 at the municipal level. Consequently, we imputed data for the two elections when corresponding data were not available using a linear interpolation or extrapolation of that census variable in that municipality in the closest available years.

[38] Blais, Gidengil, and Nevitte 2004; Geys 2006; Gray and Caul 2000; Rosenstone 1982.

[39] In seven other cases, municipalities did not hold elections in a given year. If this missing year was *not* immediately before or after internet voting's introduction and there were at least two data points to average with the same treatment status, we averaged the turnout data with the same treatment status in order to avoid dropping these units entirely from the study. If we instead drop this data, and reduce the sample size to 89 units, the estimated effect is substantively similar: a 3.1-percentage-point increase in turnout with a standard error of 1.7 percentage point.

[40] If the results were eliminated using this test, this would indicate that units may be selecting into treatment based on pre-existing trends. In this case, the concern would be that units already increasing in turnout were more likely to adopt internet voting. Since the effect is stable after unit-specific linear time trends are included, this is unlikely to be the case.

TABLE 1 *Internet Voting's Effect on Turnout*

Internet voting (Treatment)	0.035*	0.036†	0.036*
	(0.016)	(0.019)	(0.016)
Population (log)			−0.195
			(0.178)
Population density (log)			0.362*
			(0.136)
Unemployment rate			0.002
			(0.003)
Median income (log)			0.013
			(0.088)
Population with university degree			0.131
			(0.204)
Population aged 65+ (%)			0.114
			(0.665)
Immigrant Population (%, log)			−0.019
			(0.037)
N	96	96	96
Fixed effects	Y	Y	Y
Unit-specific linear time trends	N	Y	N

Note: robust standard errors, clustered at municipal level. Intercepts are not reported. Significant at $^{\dagger}p < 0.10$; $^{*}p < 0.05$

method. Would a 3.5-percentage-point increase in turnout potentially change the electoral results? In our dataset, 12 per cent of competitive mayoral races had margins of victory less than 3.5 percentage points.[41] In these races, it is conceivable that new, internet voters could change the outcome if they held different preferences than traditional, paper ballot voters.

For several reasons, our estimated effect may be smaller than the actual effect. First, there is likely some measurement error attributable to poor municipal record keeping. Using fixed effects estimators with data that has measurement error will generally push estimates closer to zero. Secondly, we could plausibly hypothesize that internet voting's effect on turnout would be larger if it was introduced later in time, because internet use is much higher in 2014 than it was in 2003 when several municipalities adopted internet voting. Finally, in Ontario internet voting was often adopted after VBM was already put in place. If this earlier adoption of a convenience method already increased turnout, we would be unlikely to see further increases after a second convenience method – internet voting – was later adopted.

For this reason, we examine how other electoral reforms could affect internet voting's effect on turnout, including whether VBM was already implemented and whether paper ballots were eliminated (Table 2). Our aim is to understand whether earlier VBM adoption dampens internet voting turnout increases, and whether making voting less public, by eliminating polling stations altogether, decreases turnout. Using the same fixed effects models, we find that the estimated effects of internet voting on turnout are twice as large after controlling for VBM introduction and paper ballot elimination. These results are robust to including linear time trends and census controls. This suggests that if VBM is already in use as a convenience method, internet voting's effect on turnout is meaningfully dampened. This may also help explain why studies examining the effect of internet voting in jurisdictions where VBM is already in use, including Switzerland, find null results.[42] Since our study was not designed to assess the effect of VBM adoption on turnout, we lack baseline pre-treatment data for many municipalities that adopted VBM. Thus, we caution over interpretation of the large 9.5 pp estimated effect. That said, it is a reasonable estimate given that previous studies have found larger VBM effects in lower-salience local elections ranging from four to ten.

[41] Twenty-six out of 225 competitive electoral races without internet voting (without missing data).
[42] Germann and Serdült 2017.

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TABLE 2 *Internet Voting's Effect on Turnout, Controlling for other Electoral Reforms*

Internet voting (IV)	0.072***	0.072**	0.074***
	(0.018)	(0.023)	(0.018)
Vote by mail (VBM)	0.095***	0.096***	0.096***
	(0.018)	(0.028)	(0.018)
Paper ballots eliminated (PBE)	0.008	0.007	0.007
	(0.016)	0.026	(0.016)
N	96	96	96
Fixed effects	Y	Y	Y
Unit-specific linear time Trends	N	Y	N
Census covariates	N	N	Y

Note: robust standard errors, clustered at municipal level. Intercepts are not reported. Significant at $^{**}p < 0.01$; $^{***}p < 0.001$

TABLE 3 *Variation in Electoral Rules Estimated Effects on Internet Voting Use*

No Registration Barrier	0.383***
	(0.056)
Paper Ballots Eliminated	0.113***
	(0.027)
Advance Internet Voting Only	–0.101
	(0.066)
N	96
Fixed Effects	Y
Census Covariates	Y

Note: outcome variable is percentage of voters using the internet to cast their vote. Robust standard errors, clustered at municipal level. Intercepts are not reported. Significant at $^{***}p < 0.001$

EFFECTS OF VARIATION IN INTERNET VOTING RULES

Next, we examine how variation in rules affected internet voting usage. We examine whether requiring additional registration, only allowing internet voting to be used in advance of election day, or eliminating paper ballots affected citizen's use of internet voting. This analysis relies on a shorter, two-year version of the panel dataset – one control year (2000) and one treatment year (2014). The sample includes the ninety-six municipalities in Ontario that used internet voting in 2014. In this model, the percentage of voting citizens using the internet to cast their ballot is the outcome variable. Hence, this model focuses on which factors predict citizens' choosing the internet as their voting method. We use these three electoral rules, which vary across local elections as the independent variables, and the proportion of voting citizens using internet voting as the dependent variable. We include census variables as controls.

As Table 3 shows, the results are straightforward. Controlling for other factors, increasing barriers to internet voting decreases its use, while eliminating paper ballots increases its use. When registration barriers are eliminated, more people choose to vote via the internet (38 percentage points), controlling for other factors. Similarly, when paper ballots are eliminated, more people choose to vote via the internet (11 percentage points). Note that this result is likely constrained by the fact that remote areas were more likely to eliminate paper ballots, given the longer distances citizens would have to travel to vote. Thus we should expect these places to already have comparatively higher internet voting use, which they do. Although allowing citizens to only vote by internet in advance of election day has a substantively large and negative coefficient, it is not quite statistically significant given the small sample size.[43] Still, this suggests that only allowing advance voting by internet could reduce its use, and more work could be done to examine this using a larger sample size. Clearly, how internet voting is implemented can dramatically affect whether or not citizens use it.

[43] To reiterate, only six municipalities used this rule, making the effect difficult to identify in our dataset.

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CONCLUSION

Voting by internet is the latest electoral reform to increase voting convenience. Allowing citizens to use the internet to vote anywhere at any time dramatically reduces voting's cost, to a level people expend numerous times a day online. Yet determining whether (and to what extent) adopting internet voting affects turnout has proven challenging. Rather than comprehensive, counterfactual assessments, many governments have relied on poor information when attempting to determine internet voting's effect on turnout. While researchers have made great efforts to understand the possible effects of internet voting reforms, data availability and implementation have created barriers.

In this article, we attempt to overcome some of these challenges in order to provide better estimates for policy makers and researchers about internet voting's potential to increase turnout. We also examine how specific electoral rules might change the technology's use. Using fixed-effects estimators, we find a stable turnout effect of 3.5 percentage points. Our findings are consistent with other research on reducing voting costs through convenience electoral reforms. As Gronke et al.[44] observe, generally 'research concludes that convenience voting has a small but statistically significant impact on turnout, with most estimates of the increase in the 2–4 per cent range'. Our findings suggest it is not simply a matter of increasing convenience even further to significantly boost turnout.

Although we find a 3.5-percentage-point effect using this case, it is useful to consider what contextual factors might increase or decrease the technology's impact on electoral participation. First, we should expect that internet voting will have a smaller effect on turnout where the cost of voting has already been reduced through other convenience voting reforms. In line with this hypothesis, we find that the magnitude of the internet voting effect doubles if it is introduced in places where VBM was not used. Likewise, in Switzerland, a similar increase was found after the adoption of postal voting;[45] but when internet voting was added, researchers found no additional effect on turnout.[46] There is likely a ceiling on how much convenience can increase turnout, and layering on additional convenience reforms likely boosts turnout by smaller additional margins, if at all. Effects could also vary by the level of government being elected. Local elections are notoriously low salience, with consequent low turnout. Research indicates that VBM has a greater effect in low-participation elections.[47] Thus internet voting's effect on turnout in local elections is likely larger than we might find for elections with higher baseline participation levels.

That said, voting costs can explain part of the story in Ontario. Changes to different voting modes' relative costs affect citizens' choices. If the costs of voting by internet are higher, for example through registration requirements, fewer citizens use the option. Similarly, only offering internet voting in advance of election day, as is the case in several jurisdictions including in Estonia, may decrease the technology's effect on turnout. Although our results are not conclusive, given our data only include six municipalities with advance voting, it is conceivable given our point estimate of −10 pp that only offering advance internet voting reduces its use. Overall, our research suggests that the relative costs of different voting methods may be more important to understanding which *way* citizens choose to vote than the overall cost of voting is to understanding *whether* some citizens will vote at all.

Using a similar approach and larger datasets, future research could test a number of hypotheses on the cost of voting, voting visibility and internet voting more directly. Open questions include whether making voting less public and visible reduces turnout – in the Ontario case, our preliminary results suggests this is not the case. Researchers could also examine whether changes in the voting methods offered alter the composition of the voting population, either by reducing or exacerbating socio-economic biases. We do not know how much internet voting changes infrequent and non-voters' habits – whether or not it is bringing new or less committed participants consistently into the electoral process. Future studies could also examine discontinuing internet voting's effect on electoral participation, as the reform has stopped in some jurisdictions. All of these open questions can be examined with larger datasets, time periods and

[44] Gronke et al. 2008, 442.
[45] Luechinger, Rosinger, and Stutzer 2007.
[46] Germann and Serdült 2017.
[47] Karp and Banducci 2000; Kousser and Mullin 2007.

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units, and attention to research design and identification, given constraints from the policy's design and implementation.

While internet voting is far from a silver bullet, it may bring some citizens back into the electoral process and prevent others from leaving it. In the Ontario case, the reform increased the effective voting population by 8 per cent, potentially changing the results in 12 per cent of competitive mayoral elections. In places where VBM was not yet used, these results are twice as large. Notably, even more dramatic electoral reforms may not have much larger effects. For example, adopting a proportional representation system has been shown to increase turnout by 5 percentage points.[48] Only compulsory voting laws show a much larger change, increasing turnout by 7–16 percentage points in advanced democracies.[49] Ultimately, internet voting is but one of a number of electoral reforms designed to change the cost, visibility and importance of voting. To more fully counter turnout declines, reformers should consider more complex models than cost alone to explain why citizens increasingly fail to vote. That said, our research suggests internet voting can deliver turnout payoffs similar in magnitude to larger and more difficult electoral reforms.

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