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How do the characteristics of voting advice application users change over time? 
Evidence from the German Election Studies

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Abstract

Unequal and declining electoral turnout has spurred numerous initiatives to reverse the trend. Voting advice applications (VAAs) are one prominent attempt. VAAs match the opinions of voters with those of candidates or parties. As the popularity of VAAs increases and research corroborates their effect on turnout and political preferences, it matters at lot who uses VAAs and, thus, experiences these effects. The early VAA literature found that VAA users tend to be young, well-educated, politically interested men. For the first time, this article assesses whether this pattern changes over time. Using German election data, it measures whether age, gender, education, and political interest still explains VAA use. Age remains important, while gender is no longer significant. Those with the highest levels of education remain significantly more likely to use VAAs, but this is no longer true for those with moderate levels of education. Political interest remains an important predictor of VAA usage. Overall, we have thus seen a development in which users become more similar to the population as a whole. A development which corresponds to Rogers’ diffusion thesis. This is important in light of the continued interest in unequal political participation as it suggests that VAAs may, in the long term, be able to reach groups in society currently not engaged in the political process.
Introduction

Electoral turnout is declining across contemporary democracies (Blais 2007; Gray and Caul 2000; Hooghe and Kern 2017; Schlozman, Brady, and Verba 2018). In Germany, this has been the case for decades, despite an upturn in the 2017 general election. Furthermore, turnout in Germany is lower in less affluent regions (Schäfer and Schwander 2019). Declining electoral turnout, especially if differentiated by socially salient factors, is widely considered a cause for concern (Lijphart 1997). Such a decline is problematic across a wide range of understandings of why elections are valuable. If the purpose of elections is to aggregate political interests into a collective choice (Arrow 1963), let citizens protect their interests (Dahl 2007), or hold incumbents accountable for past performance (Manin 1997), then it is a problem when voters do not make their voices heard. If elections are a way of respecting each citizen as moral equals (Dworkin 1987), then failing to engage large fractions of the population questions their status as equals. These worries become more poignant if the participation is systematically unequal.

In recognition of such concerns, there have been numerous proposals to reverse the trend of declining participation. This paper focusses on one such proposal, voting advice applications (VAAs), in a German context. Using VAAs, voters fill in their opinions on a number of issues, and the VAA informs them which parties or candidates competing in the election are closest to them on these issues. From modest beginnings on paper and floppy discs (De Graaf 2010), the popularity of VAAs has soared since the emergence of internet-based VAAs two decades ago (Garzia and Marschall 2019).

The academic interest in VAAs matches their increased importance to the electorate (Cedroni 2010; Garzia 2014; Garzia and Marschall 2012; 2019). VAAs are found to affect voter turnout and vote intention (Dumont and Kies 2012; Gemenis and Rosema 2014; Marschall and
Schultze 2012; Garzia and Marschall 2012; 2019; Garzia 2010; Garzia, De Angelis, and Pianzola 2014; Garzia, Trechsel, and De Angelis 2017; Germann and Gemenis 2019; Ladner and Pianzola 2010; Pianzola et al. 2019; Rosema, Anderson, and Walgrave 2014).¹ There is also considerable evidence that VAA usage affects party choice (Alvarez et al. 2014; Gallina 2018; Garzia 2010; Israel, Marschall, and Schultze 2017; Enyedi 2016; Kamoen et al. 2015; Pianzola 2014; Ruusuvirta 2010; Wall, Krouwel, and Vitiello 2014).²

However confident we may be in the ability of VAAs to affect those who use them, their importance depends on who these users are. If we are concerned about unequal turnout, the ability of VAAs to play a role in correcting this depends on reaching those currently disengaged in politics.³ Using German election data, this article examines how the characteristics of VAA users have developed over time. The enquiry connects to a broader literature on digital divides and the spread of communication technologies in contemporary societies. It contributes to our understanding of how technology-based democratic innovations spread across society.

¹ For a recent, more skeptical view, see (Gemenis 2018)

² Another branch pertains to the design of VAAs. This includes different ways of aggregating and comparing answers (Baka, Figgou, and Triga 2012; Van Camp, Lefevere, and Walgrave 2014; Germann et al. 2015; Holleman et al. 2016; Lefevere and Walgrave 2014; Louwerse and Rosema 2014; Wagner and Ruusuvirta 2012), as well as different ways of formulating questions (Gemenis 2013; Germann et al. 2015) and placing parties (Andreadis and Giebler 2018; Garzia, Trechsel, and De Sio 2015; Krouwel and van Elfrinkhof 2014; Otjes and Louwerse 2014).

³ The same is true if we are concerned about political knowledge. For findings about knowledge, see (Fivaz and Nadig 2010; De Rosa 2010; Kamoen et al. 2015; Schultze 2012; 2014; Westle, Begemann, and Rütter 2015),
The article, first, presents existing knowledge about VAA users. Based on the literature on how information technologies spread across societies, four hypotheses are developed. The data and methods section describes the data from the German Election Studies (GLES) and its suitability for testing the hypotheses. Then, it explains why logistic regression is employed. After a brief descriptive analysis, the next section conducts a multivariate analysis to assess the hypotheses. A penultimate section addresses the limits of the analysis. The conclusion discusses the implications of the findings.

VAA users and hypotheses

To develop hypotheses about VAA users, we should first consider findings in the existing literature. Three comprehensive literature reviews provide a natural starting point. Cedroni concludes that the typical VAA user ‘is young, highly educated, and keenly interested in politics’ (Cedroni 2010, 253). Later reviews also conclude in terms of gender. Garzia and Marschall summarise that ‘the typical VAA user is male, young, well-educated, and highly interested in politics’ (Garzia and Marschall 2012, 222 n5). A 2014 review concludes that VAA users are ‘on average male, young, highly educated and politically interested’ (Marschall 2014, 102) – a claim underpinned by early VAA studies (Boogers and Voerman 2003; De Rosa 2010, 190; Garzia and Marschall 2012; Hooghe and Teepe 2007; Marschall 2008; Marschall and Schmidt 2010, 80; 2008; Marschall and Schultzze 2012; Ruusuvirta 2010, 55; Wall et al. 2009). Recent studies corroborate these conclusions (Dumont and Kies 2012; Marschall 2014). It is thus a well-established fact that VAA users tend to be highly educated, politically interested young men.

This article adds to our knowledge about VAA users by providing a longitudinal perspective, which also takes into account the development among non-users. The article connects
the VAA literature to the literature about technology and democratic innovation. The digital divide literature provides two competing hypotheses regarding the ability of technology to diminish participatory inequalities. The hope that technology would mobilise the marginalised is the mobilisation thesis. However, new technologies could also reproduce inequalities. This bleaker expectation is the normalisation hypothesis (Norris 2001). While the unequal VAA usage patterns established by the literature might seem to corroborate the normalisation hypotheses, the cited studies are not new and do not assess the development over time. What should we expect in this regard? The VAA literature does not provide much input. Marschall suggests that ‘it could be hypothesized that the larger the user group becomes, the more representative of the online community and the population it might become’ (Marschall 2014, 102). However, this remark cannot in itself substantiate the development of hypotheses about VAA usage over time. As contemporary VAAs are internet-based, we can learn from the digital divide and the literature on the social uptake of technology and information offerings.

As the internet spread across countries, the literature on a digital divide emerged (Norris 2001). The early iterations of this literature identified a prevalent inequality of access (Hargittai 2004; Norris 2001). As the access inequality diminished, the literature transformed to identify inequality of use (van Dijk 2006; DiMaggio et al. 2004; Warschauer 2004). It found inequalities related to gender (van Deursen, van Dijk, and ten Klooster 2015; Helsper 2010; Pan et al. 2011), age (Neves et al. 2018; Pan et al. 2011; Willis and Tranter 2006), and socioeconomic position (Hargittai and Hinnant 2008; Pan et al. 2011; Willis and Tranter 2006). Furthermore, several studies identify inequalities in the political use of the internet along these parameters (Hoffman and Schechter 2016; Min 2010; Schlozman, Verba, and Brady 2010).

A prominent theory explaining the uptake of Information and Communication Technologies (ICTs) is Rogers’ diffusion thesis. It describes how ICTs spread across societies
(Rogers 2010) and is thus useful for developing hypotheses for a longitudinal analysis of VAA usage. Rogers’ theory predicts that the diffusion of technology in society follows a bell-shaped pattern. At first, technologies are only used by a minority of early adopters but, later, become more prevalent and spread to the rest of society. Early adopters differ in age, educational levels, and other social characteristics from later adopters (De Marez, Evens, and Stragier 2011). Thus, using diffusion theory, we would predict that VAA usage would, from an unequal starting point, become more normal. In their summary of Rogers’ work, De Marez, Evens, and Stragier portrait early adopters of ICTs (De Marez, Evens, and Stragier 2011). These are quite similar to the users identified by the VAA literature. This strengthens the plausibility of formulating the hypotheses based on Rogers’ work.

Thus, we may expect the four key characteristics of VAA usage to become less important over time because the characteristics of users become more similar to the population as a whole. From a starting point where VAA users are more likely to be young, well-educated, politically interested men, we should find the following over time:

**H1:** Age matters less for predicting VAA use.

**H2:** Gender matters less for predicting VAA use.

**H3:** Political interest matters less for predicting VAA use.

**H4:** Education matters less for predicting VAA use.

**Data and methods**
This article conducts a regression analysis of German election data from 2009 and 2017 to test whether age, gender, political interest, and education are less important for predicting VAA use. This section presents the data employed and elaborates on why regression analysis is suitable for testing the hypotheses.

German data is conducive to the analysis. VAAs are very popular in Germany, especially Wahl-O-Mat, which has been a mainstay of German elections since 2002. From 3,600,000 users in its first national election, Wahl-O-Mat had 15,700,000 users in the 2017 German election (Bundeszentrale für politische Bildung 2019). Both the popularity and the longevity of Wahl-O-Mat makes the German case relevant for testing the hypotheses. It allows for eight years between our points of comparison, and these are not from introduction to present day. We are evaluating how a mature VAA fares.

The article employs data from the German Election Studies. Specifically, the German Longitudinal Election Study of the German general elections in 2009 and 2017 is used. Thus, this article conducts a secondary analysis of data collected for the GLES. Relevant parts of these studies are identified based on their inclusion of relevant variables pertaining to age, gender, education, political interest, and VAA use. For 2009, the GLES 2009 Pre- and Post-Election Cross Section

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4 For a discussion about the context of the elections, see (Bräuninger et al. 2019; Laubenthal 2019; Krewel, Schmitt-Beck, and Wolsing 2011; Roßteutscher, Schmitt-Beck, Schoen, Weßels, and Wolf 2019; Siri 2018; Wurthmann et al. 2020; Zohlnhöfer 2011)

5 For a discussion about the history and design of the Wahl-o-Mat, see (Bundeszentrale für politische Bildung 2019; Marschall 2008; 2005)

6 Regarding the recoding of variables, see the appendix. VAA questions refer to ‘special information offerings, such as the “Wahl-o-mat” or “Kandidatenwatch”. Users include those using
(Cumulation) is employed (Rattinger et al. 2017). The survey totals 4,290 realised interviews (2,173 pre-election and 2,117 post-election) (GLES 2019a). The questions relevant for testing the hypotheses were asked in both the pre- and post-election surveys. As the samples are independent in the sense that different people are surveyed before and after the election, the analysis includes both pre- and post-election respondents. The pre-election interviews were conducted from August 10th 2009 to September 26th 2009, while the post-election interviews were conducted from September 28th 2009 to November 23th 2009 (GLES 2019a). The general election was held on September 27th 2009. For 2017, a different part of the GLES survey is employed because the 2017 Pre- and Post-election Cross-Sectional (Cumulation) study did not ask about VAA use. Therefore, the pre-election survey from the Rolling Cross-Section Campaign Survey with Post-Election Panel Wave is employed to analyse 2017 (Roßteutscher, Schmitt-Beck, Schoen, Weßels, Wolf, et al. 2019). The study provides 7,650 respondents and includes the relevant questions for testing the hypotheses. (GLES 2019b). The pre-election interviews were conducted from July 24th 2017, to September 23th 2017. The general election was held on September 24th.

While the surveys from 2009 and 2017 employed for comparison are from different parts of the GLES, they are similar in many relevant aspects, which makes them suitable for comparison. Most importantly, they employ similar sampling strategies. Both surveys are a

other VAAs than Wahl-o-Mat and those using Kandidatenwatch (which is not a VAA but provides information about candidates). With the popularity of the Wahl-o-Mat, it seems fair to believe that the vast majority of users have used a VAA.

7 The corresponding 2009 survey did not ask about VAA use.

8 In this study, the post-election survey contacts the same respondents again (GLES 2019b). As these are the same persons interviewed in the pre-election survey, they are not used for the analysis.
multistage random sampling of the German electorate\textsuperscript{9} based on the ADM-design system (GLES 2019a; 2019b),\textsuperscript{10} which allows for a random and representative sampling of Germans (ADM.de 2020). The weights in both datasets, which, for reasons elaborated below, are employed in this study, are also very similar. They are post-stratification weights calculated using iterative proportional fitting (IPF) (GLES 2019a; 2019b). The method of inquiry differs slightly. The 2009 survey is a Computer Assisted Personal Interview (CAPI), while the 2017 survey used a Computer Assisted Phone Interview (GLES 2019a; 2019b). For questions enquired about here, there is no reason to expect this to affect the answers. Based on these similarities in samplings, variables, and weighting, it seems reasonable to compare the surveys to assess the hypotheses.

Another difference is that for 2009, the respondents from the post-election survey are included in the analysis. The purpose is to increase the number of respondents and, thereby, the statistical power of the comparison. However, a worry could be that adding the post-election respondents might systematically affect our measure for 2009. This would be the case if the post-election respondents were very different from the pre-election respondents. However, this is not the case, as shown in the appendix. Therefore, the inclusion of the post-election respondents is deemed reasonable. With similarly collected data, which employs similar weighting methods and includes relevantly similar variables, it seems reasonable to compare the development of VAA usage employing these two parts of the GLES.

\textsuperscript{9} The 2009 survey also includes citizens 16 and 17 years old. For similarity, these respondents are excluded from the analyses. This leaves 4,239 respondents for 2009.

\textsuperscript{10} Arbeitskreis Deutcher Marktforschingsinstitute.
The last part of this section considers which methodological approach is best for testing the hypotheses. Specifically, it considers other data sources and comparisons before arguing that the regression analysis approach is suitable.

Consider, first, which comparisons to make. We cannot merely compare the development of means of relevant variables for users between 2009 and 2017. This method fails to capture whether changes among users reflect a broader development in the population. If, for example, a change in the composition of users’ political interest is matched by a similar change in the general population, the change in user characteristics is less interesting.

If we cannot merely compare users in 2009 and users in 2017, we must ask what we should compare users to. The approach taken here is to compare VAA users with non-users, understood as those in the German electorate who have not used a VAA. An alternative approach would be to only compare users to non-users among those connected to the internet. As VAAs are internet-based, it would be interesting to know whether VAA users become more similar to internet users as a whole. Besides pointing out that the data for this comparison is not ideal and that the conducted comparison fits better with Rogers’ theory, the major reason for comparing users to the population as a whole is that this comparison is more conclusive because of the huge uptake of internet usage in Germany in the period. Between the two elections, the share of the German population who uses the internet rises with approximately 10 percentage points (Statista 2020). The percentage of Germans online is estimated to be 96% in a 2019 survey (deutschland.de 2019). A control group that changes this much and that we only have inadequate data on would not provide as good a comparison. Furthermore, this comparison would come with a loss of statistical power because the groups of non-users would be smaller, but also because the questions for capturing this are not precise. The question about internet use in 2009 asks whether people have used the internet
for non-work purposes during the last week. In 2017, there is no question about internet use as such, only about using the internet to obtain political information. We thus do not have proper measures to compare VAA users to internet users. For these reasons, VAA users are here compared to all those who have not used the VAA.

Consider, then, alternative sources of data. Traditionally, data about VAA users was collected through user surveys administered at random to VAA users after they have completed the VAA. Data collected in this way suffer from self-selection problems as we might expect those who opt for such a survey to be even less similar to the general population than the typical VAA user. This worry is corroborated by the few studies that address the characteristics of these users (Dumont and Kies 2012, 397; Marschall and Schultze 2015). Another problem with this kind of data is that it does not provide us with information about non-users. For these reasons, election survey data is preferable for making the comparison undertaken here.

Another alternative that could provide data on both users and non-users would be web-based surveys. There are two problems with using these for the present purposes. The first is that web-based surveys, by definition, provide a picture of the internet-using population rather than the population as a whole. The other is that because of differences in how such studies are administered, they might be unsuitable for conducting the longitudinal comparison needed to test the hypotheses investigated here.

11 This is only asked in the post-election survey.

12 The VAA literature uses self-reported effects less for similar reasons (Garzia et al. 2014; Garzia and Marschall 2012, 2013).

13 An example would be the Respondi survey (part of the GLES) used by (Marschall and Schultze 2015).
Having argued for the need for a longitudinal approach, which compares users and non-users broadly construed and showed that the German Election Studies (GLES) from 2009 and 2017 provides us with relevant data for assessing the hypotheses, we can assess how best to test the hypotheses. The article employs logistic regression, treating VAA use as the dependent variable and age, gender, education, and political interest as independent variables. This allows for a test of whether and to what extent these factors are significant for predicting VAA usage. Logistic regression is preferable to OLS regression as the dependent variable is dichotomous. The logistic regression is preferred to traditional tests of means differences, such as the t-test, because logistic regression conducts a single test of the importance of each variable rather than independent tests of each. Conducting logistic regression on models for each of the relevant years provides insights into whether the features often associated with VAA use are changing in the direction predicted by the hypotheses and whether they remain significant predictors of VAA use.

Both the 2009 and 2017 datasets include weights to ensure that they provide an adequate geographic and sociodemographic picture of the population (GLES 2019a; 2019b). These weights are, as already mentioned, similarly constructed. For both years, the combined sociodemographic and geographic weights are employed in all subsequent analyses. For both 2009 and 2017, these weights ensure that the measures of gender, age, education, and geography are more precise. The need for analysing weighted data can be illustrated by the fact that for the unweighted data, the proportion of those with a higher education increases by 30 percentage points from 2009 to 2017. For the weighted data, there is still an increase, but this is at a much more modest six percentage points. When the unweighted data include substantial changes in, for example, the age of the population and a radical change in educational composition, it will allow for a less reliable test of the hypotheses at hand. Therefore, weighted data is used throughout the regression analysis.
Descriptive analysis

This section provides a descriptive overview of the data. First, it provides descriptive information about the samples of the general population in 2009 and 2017, respectively.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents</td>
<td>4,239</td>
<td>7,650</td>
</tr>
<tr>
<td>Male share$^{14}$</td>
<td>48.48% (2,055)</td>
<td>48.66% (3,722)</td>
</tr>
<tr>
<td>Mean age$^{15}$</td>
<td>49.33</td>
<td>52.14</td>
</tr>
<tr>
<td>Education$^{16}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Lower</td>
<td>43.38% (1,814)</td>
<td>36.33% (2,741)</td>
</tr>
<tr>
<td>- Medium</td>
<td>30.33% (1,268)</td>
<td>31.58% (2,383)</td>
</tr>
<tr>
<td>- Higher</td>
<td>26.28% (1,099)</td>
<td>32.10 % (2,421)</td>
</tr>
<tr>
<td>Political interest$^{17}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Low political interest</td>
<td>36.81% (1,555)</td>
<td>17.03% (1,303)</td>
</tr>
<tr>
<td>- In between</td>
<td>40.10% (1,694)</td>
<td>39.52% (3,023)</td>
</tr>
<tr>
<td>- High political interest</td>
<td>23.08% (975)</td>
<td>43.45.% (3,324)</td>
</tr>
</tbody>
</table>

$^{14}$ Missing: (2009=0; 2017=0).

$^{15}$ Missing: (2009=0; 2017=77).

$^{16}$ Missing/not eligible: (2009=47; 2017=104).

$^{17}$ Missing: (2009=14; 2017=3).
Table 1 tells us how the demographics have changed. The most important trends to note are the general increase in political interest, the increase in educational levels, and the rise in the proportion of VAA users, from 8.34% to 13.96%. The table below outlines the descriptive differences between users and non-users for 2009 and 2017 to obtain an initial impression of changes in their compositions.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender, share of males</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Users</td>
<td>59.83% (182)</td>
<td>57.78% (712)</td>
</tr>
<tr>
<td>non-users</td>
<td>47.45% (1,863)</td>
<td>47.24% (2,991)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Users</td>
<td>39.75 (304)</td>
<td>39.68 (1,224)</td>
</tr>
<tr>
<td>Non-users</td>
<td>50.20 (3,926)</td>
<td>54.07 (6,263)</td>
</tr>
<tr>
<td><strong>Education levels,</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Users</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>12.64% (37)</td>
<td>18.75% (225)</td>
</tr>
<tr>
<td>Medium</td>
<td>31.60% (93)</td>
<td>20.22% (242)</td>
</tr>
<tr>
<td>Higher</td>
<td>55.76% (164)</td>
<td>61.04% (732)</td>
</tr>
</tbody>
</table>

### Non-users

<table>
<thead>
<tr>
<th>Level</th>
<th>Users</th>
<th>Non-users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower</td>
<td>46.18% (1,791)</td>
<td>38.58% (2,418)</td>
</tr>
<tr>
<td>Medium</td>
<td>30.22% (1,172)</td>
<td>33.63% (2,108)</td>
</tr>
<tr>
<td>Higher</td>
<td>23.60% (915)</td>
<td>27.78% (1,741)</td>
</tr>
</tbody>
</table>

### Political interest, users

<table>
<thead>
<tr>
<th>Interest Level</th>
<th>Users</th>
<th>Non-users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low political interest</td>
<td>18.33% (56)</td>
<td>4.98% (61)</td>
</tr>
<tr>
<td>In between</td>
<td>37.65% (114)</td>
<td>32.83% (404)</td>
</tr>
<tr>
<td>High political interest</td>
<td>44.02% (133)</td>
<td>62.19% (766)</td>
</tr>
</tbody>
</table>

### Political interest non-users

<table>
<thead>
<tr>
<th>Interest Level</th>
<th>Users</th>
<th>Non-users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low political interest</td>
<td>38.54% (1508)</td>
<td>18.74% (1,187)</td>
</tr>
<tr>
<td>In between</td>
<td>40.35% (1,579)</td>
<td>40.82% (2,584)</td>
</tr>
<tr>
<td>High political interest</td>
<td>21.12% (826)</td>
<td>40.44% (2,560)</td>
</tr>
</tbody>
</table>

The descriptive data above provides an overview of the difference between users and non-users in 2009 and 2017. In terms of the gender composition of users, there has been a trend towards more gender equality. With regard to age, the difference between users and non-users has increased. In terms of the educational levels of users and non-users, stark differences remained in 2017. The share of users with higher levels of education has risen more than the share of non-users. However, people with lower levels of education form a larger share of users than they did in 2009. In terms of political interest, there was a rise among users. The share of users placing themselves in the highest category for political interest has risen from about 21% to 62%. Non-users, however, have also become more interested; the top category has almost doubled, from 21% to 40%. While the developments in the descriptive data are interesting, they do not allow us to say anything conclusive about our hypotheses. For this, we need to conduct multivariate analysis.
Multivariate analysis

This section conducts logistic regression to test whether, for each year, the relevant variables significantly explain VAA usage. Table 3 lays out the results from 2009 and 2017.

Table 3: Logistic regressions 2009 and 2017

<table>
<thead>
<tr>
<th>VAA use</th>
<th>Coef.2009</th>
<th>Coef.2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.030***</td>
<td>-0.048***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Men</td>
<td>0.290**</td>
<td>0.212</td>
</tr>
<tr>
<td></td>
<td>(0.136)</td>
<td>(0.142)</td>
</tr>
<tr>
<td>- Medium</td>
<td>0.947***</td>
<td>-0.279</td>
</tr>
<tr>
<td></td>
<td>(0.206)</td>
<td>(0.213)</td>
</tr>
<tr>
<td>- Higher</td>
<td>1.473***</td>
<td>0.538***</td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td>(0.191)</td>
</tr>
<tr>
<td>Political interest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- In between</td>
<td>0.569***</td>
<td>1.133***</td>
</tr>
<tr>
<td></td>
<td>(0.186)</td>
<td>(0.312)</td>
</tr>
<tr>
<td>- high</td>
<td>1.246***</td>
<td>1.846***</td>
</tr>
<tr>
<td></td>
<td>(0.120)</td>
<td>(0.305)</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.771***</td>
<td>-1.219***</td>
</tr>
<tr>
<td></td>
<td>(0.277)</td>
<td>(0.386)</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.

Pseudo r-squared: 2009: 0.1326; 2017: 0.1680.
The logistic regression of VAA use for 2009 shows that then, age, gender, education, and political interest were all significant explanations for VAA use at standard levels of significance (p<0.05). Moreover, the coefficients point in the expected direction. Older people are less likely to be VAA users. Men are more likely to be VAA users, and for higher levels of education and political interest, the coefficients are larger. The model as a whole is also significant. These findings are similar to the analysis of the 2009 election conducted by Marschall and Schultze on a different dataset (Marschall and Schultze 2015).¹⁹

The logistic regression for 2017 provides a different picture. Age remains a significant predictor of VAA usage, and as expected, the coefficient remains negative. Interestingly, the size of the age coefficient has increased. Gender is no longer significant in predicting VAA use. Thus, men are no longer significantly more likely to be VAA users than women. For education, the picture has also changed as the intermediate level is no longer a significant predictor of VAA usage compared to those with lower levels of education. Those with the highest level of education remain significantly more likely to use VAAs. However, the size of the coefficient is smaller than in 2009. For political interest, the pattern is unchanged. Political interest remains a significant predictor of VAA usage.

As the coefficients given by logistic regression are difficult to interpret, we also present the margins. Margins describe how the predicted probability of a positive outcome on the dependent variable (here, VAA use) changes as the independent variable changes. Table 4 reports the average marginal effects of each variable still significant in 2017.

¹⁹ In their multivariate model, age, political interest, and education are significant, but gender is not included.
Table 4: Delta Method, margins

<table>
<thead>
<tr>
<th>VAA use</th>
<th>Dy/dx 2009</th>
<th>Dy/dx 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.002</td>
<td>-.005</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Higher</td>
<td>0.093</td>
<td>0.060</td>
</tr>
<tr>
<td>Political interest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- In-between</td>
<td>0.030</td>
<td>0.072</td>
</tr>
<tr>
<td>- High interest</td>
<td>0.088</td>
<td>0.152</td>
</tr>
</tbody>
</table>

Table 4 shows that the effect of age has increased. Thus, people’s age matters more for VAA use in 2017 than it did in 2009. For education, it is interesting to note that while higher levels of education remain significant, the size of the effect has decreased. Furthermore, the effect of political interest has increased.

Results

The development regarding the age of VAA users turns out to falsify the first hypothesis. Age remains a significant predictor of VAA usage, and the effect of age increased from 2009 to 2017. The hypothesis regarding gender cannot be falsified, and the findings corroborate this. In 2017, gender is no longer a significant predictor of VAA usage.
The analysis corroborates the hypothesis regarding education to the extent that education in various ways becomes a less important predictor of VAA usage. While those with a higher level of education remain more likely to be VAA users than those with lower levels, this is no longer the case for the group with medium levels of education. It is also worth noting that the size of the effect of high levels of education has decreased, as expected per Hypothesis 2.

For political interest, we see a somewhat similar pattern. The groups of high and medium interest remain significantly more likely to be VAA users. The size of the effect has increased for both groups. This finding thus falsifies our expectations.

While there may still be inequality in VAA use, it is decreasing over time, even when we take into account changes in the population. VAA usage seems to follow the expected trend towards more equal usage patterns. This suggests that VAA usage follows the pattern described by Rogers and, thus, that their ability to affect the less engaged part of the population increases over time.

**Limitations of the study**

While the analysis above is deemed able to assess the formulated hypotheses, it is crucial to consider the limitations of the comparisons and the results.

The first limitation arises because we do not know whether those who used VAAs in 2009 are also users in 2017. With independent samples in 2009 and 2017, the data does not allow us to test this. We do not know whether the 2009 users are a perfect subgroup of the 2017 users or if the groups are completely distinct. To see how this matters for our analysis, it is instructive to consider these two extreme scenarios, even if the truth is probably somewhere in-between. If everyone who used a VAA in 2009 also used it in 2017, it means that the new users are so different
from the previous ones that the significance of the explanatory variables changes. In this scenario, the observed changes say a great deal about the new users. If everyone who were VAA users in 2009 did not use it in 2017, the results presented above would indicate the same. Then, the change in significance levels would still indicate that the users in 2017 are different from the users in 2009.

The causal relationship between some of the variables used in the analysis gives rise to another limitation. While the analysis treats political interest as a cause of VAA use, we cannot know the direction of causality. Perhaps some became politically interested because they took the VAA. Both self-reported studies of VAA users (Fivaz and Nadig 2010; Ladner, Felder, and Fivaz 2010) and statistical analysis of panel data suggest such an effect (Manavopoulos et al. 2018). There could also be a feedback effect, where political interest increases the likelihood of VAA usage, which, in turn, may increase political interest. If such mechanisms are in place, we will tend to overestimate the importance of political interest in explaining VAA usage as the level of political interest is affected by VAA usage. Two replies are possible to such a concern. The first is that this mechanism would be present in both 2009 and 2017 and that we have little reason to expect that it has changed in size. Then, the comparison between the years remains relevant although we should be cautious with comparing effect sizes, something the analysis does not rely heavily upon. The other reply is that while it might be the case that VAA use affects the level of political interest, it seems unlikely to be the major determinant of this. If so, we can still expect people’s initial level of political interest to be important for whether they use the VAA in the first place.

Another limitation springs from the use of weighted data. Because different weights apply for the 2009 and 2017 datasets, some tests are unavailable. While the results section mentions that coefficients change over time, we cannot test the significance of these changes. Traditional tests for this, such as seemingly unrelated estimation, cannot be applied. While this limitation is important, some of the changes are so large that they make factors that previously explained VAA
use insignificant. These changes are significant in the relevant sense and are used to test the hypotheses.

The timeframe of the paper provides another limitation. While eight years between the two elections leaves adequate room for assessing the hypotheses, we should acknowledge that as time passes, we will have a more complete picture available. Ideally, the tests conducted in this paper should be repeated in later articles to ascertain whether the development detected in this article continues. However, testing the hypotheses over ‘only’ eight years would only be problematic if no changes were found, and far-reaching conclusions were drawn from this.

A final reflection pertains to whether the use of German data provides a limitation in terms of generalisability. As few countries have as long a VAA history as Germany and VAAs as popular as Wahl-O-Mat, the correct conclusion would not be that other countries have, like Germany, reached a point where several inequalities in VAA usage have disappeared. Instead, a more modest conclusion should be drawn, namely that, given time, we can reasonably expect inequalities elsewhere to decrease.

**Conclusion**

As many countries experience declining and unequal electoral turnout, it becomes important to assess attempts to reverse the trend. As VAAs have become an integral part of contemporary elections and are regularly found to affect electoral turnout and political preferences, they constitute a prominent attempt to reverse declining and unequal participation. The early VAA literature provided a snapshot of early users as tending to be young, well-educated, politically interested men. The unequal pattern of initial usage corresponds well to the predicted profile of early uptake of
Information and Communication Technologies (ICTs) described by Rogers’ diffusion thesis, which also predicts that use would become less unequal over time.

Using German election data from 2009 and 2017 to assess the evolution of VAA users provides insights into how this tool has spread through the population and whether the inequalities in usage identified in the literature remain over time. When we assess the factors typically found to explain VAA use, the age gap remains, the gender gap has disappeared, and the role of education has been reduced, while political interest has become more important.

The findings are important because it tells us something about the potential of VAAs in a context of the widespread declining electoral turnout. The article’s findings suggest that VAA usage follows something akin to Rogers’ diffusion thesis. This is important because the ability of VAAs to deliver on their promise regarding the declining political inequality is ultimately based on their ability to reach those who are less engaged in politics than the early adopters. The relevant effects can only be experienced by users.\footnote{This is true even if use is unequal (Van de Pol et al. 2014) or effects are differential (Alvarez et al. 2014).} If a large part of the population does not use VAAs, then these groups will not expect the positive effects of VAA usage. So, while a digital divide remains in who engages with politics online, VAAs seemingly provide something that is able to draw new users over time in a way that makes the use of VAA less unequal. This bodes well for the ability of VAAs to play a small part in bridging rather than increasing the political digital divide and making turnout less unequal. Whether the detected development continues must be assessed by future studies. For now, the optimistic outlook provided by the mobilisation hypothesis from the digital
divide literature seems warranted. The initial digital divide has lessened over time, and the
democratic potential of VAAs has increased.

References


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https://doi.org/10.1080/19331680903109402.


https://doi.org/10.1371/journal.pone.0192119.


Appendix

1.0. Recoding of variables

VAA usage


For 2017, this variable is simple as respondents were asked the following: ‘And what about special information offerings, such as the “Wahl-o-mat” or “Kandidatenwatch”: Did you use any of them during this election campaign?’ (GLES 2019b, 36). In 2009, the question was only asked to people who had used the internet ‘to find out about political parties and the federal election on at least one day during the previous week’ (GLES 2019a, 97–98). For the present analysis, those non-internet users are coded as non-users with respect to the VAA. Those internet users who answered ‘don’t know’ to the VAA question were not included in the analysis.

Age

Variables: (2009: vn542; 2017: pre101). For 2009, the question pertains to the age of the respondent (GLES 2019a, 14). For 2017, it pertains to birth year. The latter was recoded by subtracting birth year from year of data collection. As data was collected in November, the vast majority would have had their birthdays already that year.

Gender
Variables: (2009: vn1; 2017: pre102). For both 2009 and 2017, gender is listed as observed by the interviewer. The question was only asked if the interviewer was in doubt (GLES 2019a, 14; 2019b, 45). The direction is altered so male is highest.

**Education**

Variables: (2009: vn9a; 2017: pre103). For both 2009 and 20017, the respondents were asked the following question: ‘What’s your highest level of general education?’ (GLES 2019a, 115; 2019b, 45). The answers were recoded into three categories, referred to in the text as Lower, Medium, and Higher. In the first group, those answering that they ‘Finished school without school leaving certificate’ or hold the ‘Lowest formal qualification of Germany’s tripartite secondary school system, after eight or nine years of schooling (“Hauptschulabschluss”, “Volksschulabschluss”)’ are included. In the second category are those answering ‘Intermediary secondary qualification, after 10 years of schooling’. In the final category are those answering ‘Certificate fulfilling entrance requirements to study at a polytechnical college’ and ‘Higher qualification, entitling holders to study at a university’. The remaining categories, such as ‘other’ and ‘still at school’, are not included in the analysis.

**Political interest**

Variables: (2009: vn217; 2017: pre001). For both 2009 and 2017, the subjects were asked the following question: ‘Quite generally, how interested are you in politics: very interested, somewhat interested, in between, not very interested, or not at all interested?’ (GLES 2019a, 14; 2019b, 12). Both years were recoded so that ‘very interested’ has the highest value. ‘Very interested’ and ‘somewhat interested’ were merged into one variable, and the same was done with ‘not very
interested’ and ‘not at all interested’ to avoid the analysis being affected by the fact that only few VAA users are in the ‘not at all interested’ category (especially in 2009). The merging does not change the substance of the findings.

2.0. 2009 pre-post

Are there noteworthy differences between respondents from the 2009 pre-election survey and those from the post-election survey?

<table>
<thead>
<tr>
<th></th>
<th>Pre-election survey 2009</th>
<th>Pre-election survey 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respondents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male share</td>
<td>48.53%</td>
<td>48.44%</td>
</tr>
<tr>
<td>Mean age</td>
<td>50.97</td>
<td>50.49</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Lower</td>
<td>43.27%</td>
<td>43.50%</td>
</tr>
<tr>
<td>- Medium</td>
<td>30.41%</td>
<td>30.24%</td>
</tr>
<tr>
<td>- Higher</td>
<td>26.32%</td>
<td>26.25%</td>
</tr>
<tr>
<td><strong>Political interest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Low political interest</td>
<td>34.40%</td>
<td>39.29%</td>
</tr>
<tr>
<td>- In between</td>
<td>40.50%</td>
<td>39.69%</td>
</tr>
<tr>
<td>- High political interest</td>
<td>25.09%</td>
<td>21.02%</td>
</tr>
<tr>
<td><strong>Percentage VAA users</strong></td>
<td>5.58%</td>
<td>11.17%</td>
</tr>
</tbody>
</table>