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What will be the share of e-voters in the 2017 election?

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1 The problem

Since 2005 Estonia has used remote internet voting in 8 separate occasions in local, national and European Parliament elections. Table 1 shows how this mode of voting has been picked up by voters. The growth has been impressive. When in 2005 one out of 50 votes was cast online, then in the latest national election of 2015 every third vote was given remotely over the internet.

Another e-enabled (local)election will take place in autumn 2017, this time with a fully end-to-end verifiable e-voting system. The average e-voter with non-technical background will probably not notice any differences and neither will the journalists covering the election. What has however always made people and the press curious is the question of "how many will e-vote this time?"

Table 1: E-voters in Estonia

Election	Absolute number	Share of e-voters
2005 local	9 317	1.9
2007 national	30 275	5.5
2009 EP	58 669	14.7
2009 local	104 413	15.8
2011 national	140 846	24.3
2013 local	133 808	21.2
2014 EP	103 151	31.3
2015 national	176 491	30.5

Share of e-voters is shown as the % out of all voters

Faced with having to issue a forecast with limited information available one could simply guess a number, but proceeding from the data in Table 1 and applying the logical limits the share of e-voters can theoretically have, we can do better and provide an informed estimation.

We will use only the eight data points available to come up with a best estimation.

We thank prof. Rein Taagepera for his helpful suggestions, all errors in this brief note remain ours.

2 Models

A cursory look at the information in the ultimate column of Table 1 tells us that the growth in e-voting has been quite linear over the course of 10 years. It has grown on average by roughly 5% in each election. Absent any other information we could simply assume this process continues as it is. This implies estimating a linear model:

$$X_t = \beta_0 + \beta_1 t,$$

where the outcome X_t is the share of e-voters at time t and the predictor is simply time t itself.

The problem with a linear model is that even though growth in e-voting has been basically linear up until now, such a process can not continue indefinitely. The share of e-voters is logically bound to be between 0% and 100% implying that the rate of growth will not be constant and has to slow as the logical upper limit starts to approach. Also, it is unrealistic to expect that 100% of voters will ever vote online, some share will always prefer to vote the traditional way - on paper and in the polling station. How e-voting grows is therefore a question of how an innovation diffuses among a set of users (voters)[1] and we have a large pool of models available that emulate diffusion processes [1].

Given that e-voting has natural bounds and the growth cannot be constant from a certain point onwards we chose two non-linear models. First, an exponential model:

$$X_t = \mathrm{m} - \mathrm{m}e^{-\mathrm{b}t},$$

where the outcome X_t is the share of e-voters at time t, predictor is time t and m is the ceiling for the share of e-voters.

Finally, we will also fit the widely used S-curve in diffusion studies in the form of a log-logistic model:

$$X_t = \frac{\mathrm{m}}{1 + \mathrm{c}e^{-\mathrm{b}ln(t)}},$$

where the outcome X_t is the share of e-voters at time t, predictor is time t and m is the ceiling for the share of e-voters.

3 Results

The outcome of this brief exercise is shown in Figure 1. We see that the rate of growth is predicted to slow substantially and the

[1] For a comprehensive analysis of spread and usage of e-voting in Estonia see Solvak & Vassil 2016 [2]

exponential model predicts e-voter share to hit a ceiling of 47% in the more distant future. The log-logistic model estimates the ceiling to be at 45% and the linear model is bound to produce absurdities when one extents the line into the distant future.

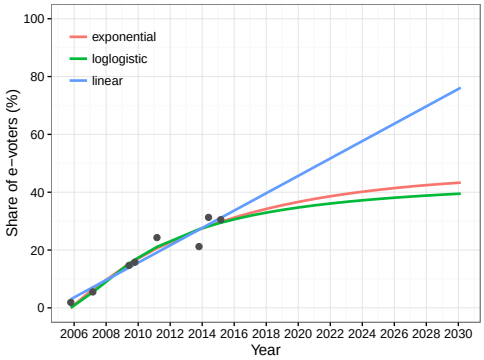

Figure 1: E-voting diffusion models

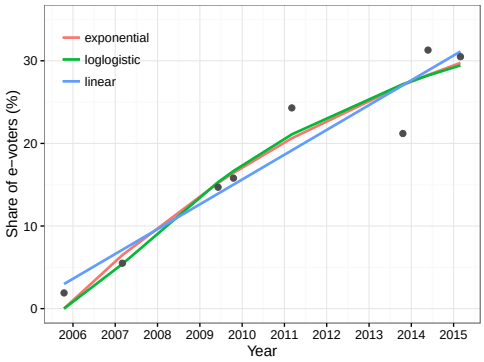

Figure 2: E-voting diffusion models (zoomed in)

Figure 2 shows the prediction lines of the models only for the eight elections over 10 years of e-voting. The exponential and log-logistic models are very similar, one simply predicts the growth rate of e-voting to start to slow faster than the other.

Table 2: Predicted share of e-voters in 2017

	E-vote share
Linear model	39%
Exponential model	34%
Log-logistic model	33%

The predictions based on these simple models for the 2017 election are listed in Table 2. We predict e-voting in 2017 to reach 33 to 34%, which is still a growth compared to 2015, but the pace of growth is already starting to slow.

Finally, we would like to issue a note of caution as well. This prediction is a simple exercise in point forecasting using non-linear diffusion models, one should take it further and compute some sort of confidence measures for this forecast given the extremely small number of data points available, but this goes already beyond the small model fitting exercise we undertook here.

Nevertheless, even with limited data you can use some simple logic and go beyond guessing and guestimating and start to estimate.

References

[1] Nigel Meade and Towhidul Islam. *Modelling and forecasting the diffusion of innovation - A 25-year review.* International Journal of Forecasting, 22(3) 519-545, 2006.

[2] Mihkel Solvak and Kristjan Vassil. *E-voting in Estonia: Technological Diffusion and Other Developments Over Ten Years (2005-2015).* Johan Skytte Institute of Political Studies, University of Tartu, 2016.