Polling in a Proportional Representation System

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Abstract

I examine a voting model where two parties have fixed positions on a uni-dimensional policy space but the implemented policy is the convex combination of the two positions and study the effects of opinion polls on election results, abstention rates and social welfare. Voters are completely agnostic about the distribution of preferences and gain sequential and partial information through series of opinion polls. Voters' behavior is driven by regret minimization and they do not vote unless they are sure they will not regret their decision. The mass of undecided voters decreases monotonically with the number of polls, but may not necessarily disappear. Voters who remain undecided have centrist ideologies. Finally, social welfare is not necessarily increasing in the number of polls. Empirical evidence about the features of the model is provided.

1 Introduction

The effects that opinion polls have on the electorate have been studied extensively. The conclusion of the literature is that the publication of polls influences how the electorate votes [Myerson and Weber, 1993]. In many countries this is reflected on past or present restrictions on how, when and if a poll should be published. The restrictions can range from a ban on publishing polls for a specific time before the elections, like in Italy (fifteen days[1]) or in Greece (fifteen days until 2014, one day since[2]), to an outright ban during the entire campaign period like in Singapore.[3] In the last decade various organizations and watchdogs have been publishing reports on these restrictions (Article19 [2003] and Spangenberg [2003]) and at the same time in many countries there have been public discussions on whether restrictions should be posed or lifted. In India

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[1]Legge 22 Febbraio 2000, n. 28, "Disposizioni per la parità di accesso ai mezzi di informazione durante le campagne elettorali e referendarie e per la comunicazione politica", article 8.

[2]Law 4315/2014, article 32.

[3]Parliamentary Elections Act, Chapter 218, article 78C.

in 2004 the main parties argued that announcing exit poll results while the elections are still going should be banned as they believed this favored certain parties[4] and in 2012 India's Chief Election Commissioner stated that opinion polls and exit polls should both be banned.[5] A 2013 survey in the United Kingdom, where there is not a ban on publishing polling results before elections in place, showed that three out of ten MPs supported the idea of such a ban.[6]

These restrictions and discussions show that the issue of the interaction between opinion polls and elections is important by both a theoretical and practical point of view. The motive behind such bans is usually to let the electorate vote "trully" without the influence of the results of opinion polls, an influence which is perceived as bad. The fear that polls may be biased, in which case the electorate might base its decision on false information, is one argument used to argue in favor of restrictions. Another argument is that basing the decision itself on the information generated by polling might distort the election results away from the "true" preferences of the electorate. Opinion polls are useful inasmuch as they clear some uncertainty in the political environment leading to more efficient decision making from the side of the political actors. Examples of uncertainty include uncertainty about valence of the candidates as e.g. in Kendall et al. [2015] or on the actual policy-ideology of candidates as in Baron [1994].

In modern parliamentary democracies where parties compete for parliament seats, these seats can be seen as a measure of political power; a ruling party that controls enough seats to just secure a majority will have to be much more moderate in its policies compared to a party that controls a larger fraction of the parliament. For this reason a moderate voter may choose to not vote for his favorite party if he feels that it may be too strong. Therefore a moderate voter who is happier with a more equal split of parliamentary seats would like to know how the rest of the voters will vote before he decides his own vote, implying that he would need to have some information about the distribution of the rest of the voters. A voter that does not have enough information may choose to abstain. This idea is analyzed by Ceci and Kain [1982] who using an experiment show that moderate voters, when instructed that the latest poll showed that a candidate "commanded a substantial lead over the other", tend to report that they would vote for the trailing one.

An interesting real life example that shows that parties understand and can try to exploit the motives of moderate voters comes from the Greek general elections of 2015. The campaigning period of these elections was very short, and during this period it was made clear that the anti-austerity and left-wing Syriza party would win the elections, since it was systematically ahead in the polls. The real question was whether Syriza would be able to form a government on its own, meaning whether it would be able to secure at least 151 out of the 300 seats in the Greek parliament. From the parties expected to enter the parliament, the anti-austerity small right-wing party Anel was the one that Syriza would be most

[4]Concern over India opinion polls (April 6, 2004). BBC News. Retrieved from: `http://news.bbc.co.uk/2/hi/south_asia/3603741.stm`

[5]Opinion, exit polls have no scientific basis: CEC (April 28, 2012). IBNLive. Retrieved from: `http://ibnlive.in.com/news/opinion-exit-polls-have-no-scientific-basis-cec/252787-3.html`

[6]Eaton, David. Should pre-election opinion polls be banned? A third of MPs think so (November 13, 2013). NewStatesman. Retrieved from: `http://www.newstatesman.com/politics/2013/11/should-pre-election-opinion-polls-be-banned-third-mps-think-so`

likely to cooperate with, on an anti-austerity basis. Anel themselves had made it clear that they would be willing to cooperate long before the elections were actually called. The previous government was a coalition of two pro-austerity parties the largest of which, the right-wing ND, was predicted to be in second place in the elections. Anel political campaigning focused on the fact that Syriza was going to win and the role Anel would play as a minority right-wing counterbalance in a government that was almost certain going to be dominated by the left. As such they targeted right-wing voters, who would otherwise vote for ND, and moderate ones who could see Syriza as being too radical, promising all their potential voters that they would control the government from within.

An important assumption of the paper is that voters behavior is driven by regret minimization. Regret can be defined as a painful emotional experience of feeling sorry of misfortunes or mistakes.[7] It is obviously a common human emotion, in fact, a study found it to be the second most frequently named emotion [Shimanoff, 1984]. Regret minimization can be expressed concretely using the *minimax regret* decision rule [Savage, 1951] according to which agents try to minimize the maximum regret their actions can incur. This rule is particularly useful when an agent that has to make a decision is aware of the set of potential future states of the world, but cannot assign any probability to them.

The goal of this is paper to examine the effects in implemented policy and welfare that public opinion polling has in a proportional representation system, and under what conditions polls lead to complete information. To do so, I construct a simple voting model in which a continuum of voters has to choose between two parties with fixed positions in a proportional representation system. Voters have imperfect information about each other's preferences and experience regret if they choose the wrong party. The voters care about the shares of the two parties because the implemented policy is a linear combination of the two parties' fixed policies, using their shares as weights. Regret minimization makes the voters very averse to mistakes, meaning that they will cast a vote for one party or the other only when they are absolutely sure that they are doing the right thing and they will prefer to abstain otherwise, because a voter wants to avoid at all costs the situation where he would vote for a certain party, but then the elections results would reveal to him that he should had voted for another one. A voter's information about other voters' preferences can be improved through a series of polls. I find the following. In the cases where some voters have some sort of incomplete information, they will prefer to not vote at all. As a result, the outcome may be quite different compared to the outcome under complete information where no voter would abstain. Abstention can be sustained in equilibrium even when the positions of the parties are perfectly known and without cost of voting. The voters most likely to abstain are the more moderate ones.

The main result of the paper is that under some condition on the distribution function of the citizens' preferences, a sequence of polls will be able to turn all

[7]In her 1993 book "Regret: Persistence of the possible", Janet Landman defines regret as follows: "*Regret is a more or less painful cognitive and emotional state of feeling sorry for misfortunes, limitations, losses, transgressions, shortcomings, or mistakes. It is an experience of felt-reason or reasoned- emotion. The regretted matters [...] may range from the voluntary to the uncontrollable and accidental; they may be actually executed deeds or entirely mental ones committed by oneself or by another person or group...*" (as cited in Li and Majumdar [2010]).

undecided citizens to voters, and if this happens the outcome of the elections will be the same with the complete information case. With every poll the abstention rate weakly decreases, as more citizens are turned into voters. However, there can be instances that after a number of polls abstention rates stop decreasing, and polls cannot provide the society with any more information. Finally, the implemented policy and citizen welfare are both not monotonic on the number of polls: the publication of one last additional poll before the elections may result in an implemented policy that is further away from the optimal policy or the policy that would be result under complete information.

To the best of my knowledge this is the only paper that examines polls and proportional representation together. It can also explain the following empirical facts at the same time, namely, the correlation between undecidedness and centrist ideologies, the non-monotonicity of election results and the decrease of the mass of undecided voters when more polls are published.

For simplicity the model of this paper only deals with two parties. However, the idea still holds to more than two parties, although then the voter must take into account the post-election interactions of the parties when coalitions need to be formed [Duch et al., 2010].

1.1 Related Literature

Various works have examined how opinion polls affect voters and parties through the information they reveal. Whenever there is some uncertainty, an objective flow of information may help minimize it. Denter and Sisak [2014] show that poll results affect campaigning spending which in turn affect how voters vote. Bernhardt et al. [2009], Morgan and Stocken [2008] and Meirowitz [2005] show that polls are used to clear uncertainty over voters preferences, but at the same time this can give rise to strategic poll answering on behalf of the voters. McKelvey and Ordeshook [1985] show that polls create a “bandwagon” effect in favor of the leading party, while Goeree and Groß er [2006] and Taylor and Yildirim [2010] show that the opposite “underdog” effect can appear, through the mobilization of the voters of the trailing party. In both of these papers it is argued that through polls the “wrong” side may win which would result in a welfare loss. Klor and Winter [2006] in an experiment show that in both close and lopsided elections polls have a bandwagon effect, but the welfare effect of the polls is ambiguous, and in a later paper [Klor and Winter, 2014] they use US Gubernatorial elections data to show that the increase in participation in elections is greater for the supporters of the leading candidate. Groß er and Schram [2010] find similar results.

The issue of voter turnout itself is a famous one in the field of political economy. Rational choice theory fails to explain the empirical results: why would voters show up to vote when they know that their individual effect to the result is insignificant combined with a positive cost of voting. Feddersen [2004] and Dowding [2005] provide overviews of the issue. In a seminal paper, Feddersen and Pesendorfer [1996] turn the question on its head and examine why, under not costly voting, the uninformed voters over the state of the world would choose to abstain in order to guarantee that it will be the informed voters the one that decide the vote.

The implemented policy as seen as a compromise among different ideological sides is not a new idea [Alesina and Rosenthal, 1996, Grossman and Helpman, 1996]. Ortuño Ortín [1997] discusses a two-party setting where implemented policy is a convex combination of the two parties' platforms generated using a continuous function of the parties' shares in the elections. Sahuguet and Persico [2006] point out that in a proportional system parties need to maximize their share (rather the probability of getting at least 50 per cent of the vote) and that the implemented policy is, is at least partly influenced by the minority party.

Various researchers have examined the idea of agents experiencing regret from their actions and how regret affects their actions themselves. Savage [1951] analyzes the minimax regret rule according to which agents try to minimize the maximum regret their actions can incur. Similarly, Loomes and Sugden [1982] argue that a theory of choice has to incorporate the fact that agents do feel regret and that they take this into account in their decision making. Zeelenberg [1999] provides a short overview of the issue of rationality of regret and argues that acting on anticipated regret can be rational, further pointing out that the minimax regret rule is useful when there is no knowledge at all about the probabilities of the possible outcomes. Most of the research on the application of regret in voting has focused on the context of the paradox of voting. Ferejohn and Fiorina [1974] point out the difference between "risk" (voters are able to assign probabilities to different states) and "uncertainty" (voters cannot assign probabilities to different states) and argue that rational behavior for a voter is not equivalent to assuming the voter is expected utility maximizer. They furthermore show that the minimax regret rule can give voter participation prediction results that are more in line with empirical observations in the presence of a cost of voting. In a later work [Ferejohn and Fiorina, 1975] they discuss the reactions to their first paper and provide empirical evidence in favor of the minimax regret rule over the expected utility maximization. Eager to test the minimax regret hypothesis directly Kenney and Rice [1989] conducted a survey which revealed that over one third of the participants could be identified as minimax regret voters. In another survey of university students Blais et al. [1995] found that a third of the participants "strongly agreed" and about forty percent "agreed" with a statement that identified minimax regret voting, and that respondents that "strongly agreed" were significantly more likely to have voted in the previous elections. However, this strong relationship disappeared once they controlled for other variables such as civic duty. In a later work Blais [2000] provided a more analytical critique of Ferejohn and Fiorina. Pieters and Zeelenberg [2005] conducted a survey of Dutch voters which confirmed that regret is an emotion that voters can feel after the elections. Recently there has been some renewed interest on regret in voting. Li and Majumdar [2010] study voter turnout and incorporate the concept of regret but not in the minimax way: how much regret a voter experiences is inversely related to the margin of victory of his favorite party. (Also see Degan and Li [2014]). Since most of the papers incorporating regret in voting are concerned with the paradox of (not) voting, each voter's decision boils down to voting for his clearly preferred side, or abstaining. In these models the action that can generate regret is abstaining which happens when their failure to go and vote leads to a bad result for their favorite side. In my model however, the action that generates regret is voting for the wrong candidate and abstaining is in fact the choice that the minimax regret rule leads them to.

In the model, voters want to avoid suffering because of bad decisions and may abstain. Degan and Merlo [2011] and Feddersen and Pesendorfer [1996] are examples of other models where citizens under uncertainty, in these cases uncertainty about candidates, may vote for the "wrong candidate", something that may inflict upon them such high cost that they may choose to abstain. Finally, voters may choose to support the party that they are least ideologically close an idea which is shared by the concept of the "protest vote", by which voters may want to punish, or control the power of their favorite party (see eg. Myatt [2013]).

The rest of the paper is organized as follows. In Section 2, I provide empirical evidence regarding the influence of polls on the implemented policy and abstention rates, and the relationship between ideology and undecidedness. This evidence is consistent with the main findings of the paper. In Section 3, I analyze the voting model and in Section 4 I discuss the predictions of the model about implemented policy and social welfare. Finally, Section 5 concludes.

2 Empirical Evidence

Abstaining of a significant portion of the population is a common feature of many elections. In the 2014 United States midterm elections the abstention rate was 63.6%, the lowest since 1942.[8] In the snap Greek general elections of 2015 the abstention rate was 36.13%,[9].

I will use the Greek case to also briefly go over some empirical evidence regarding the influence of the number of polls on the undecided vote and winner's share. After the previous parliament failed to elect a new head of state constitutional provisions forced its dissolution. The announcement of the elections took place on December 29 with the date set on January 25, making the campaigning period a little more than three weeks long. There were plenty of polls conducted by a number of public opinion polling organizations and companies. Most organizations had time to conduct four to five polls before January 25. Figure 1 shows the percentages of undecided voters reported by four polling organizations:[10] GPO, ALCO, University of Macedonia Public Polling Unit and Pulse in chronological order. The x-axis in each of the graphs shows the number of polls conducted by each organization before the elections took place.[11] Only polls conducted after the elections were called are reported because at this moment the positions of the parties must be thought as given. Furthermore, under the assumption that respondents answered thoughtfully and given that the elections were imminent, the answers are taken to represent the respondents' true voting behavior.

From the results presented here, with the exception of the University of Macedonia results, "undecided" means any voter who when asked what he would vote he did not give a party as an answer, or put it differently he is classified as "undecided" if he answered any of the following: "I will vote blank", "I will abstain", or "I don't know/ I haven't decided yet." In reporting their

[8]Charlotte Alter. 2014 midterm election turnout lowest in 70 years (November 10, 2014). PBS. Retrieved from: `http://www.pbs.org/newshour/updates/2014-midterm-election-turnout-lowest-in-70-years/`.

[9]Source: `http://ekloges.ypes.gr`

[10]The data was compiled from a number of news sources and the polling organizations own reports.

[11]Meaning that 1 signifies the last poll before the elections, 2 the second to last poll before the elections and so on.

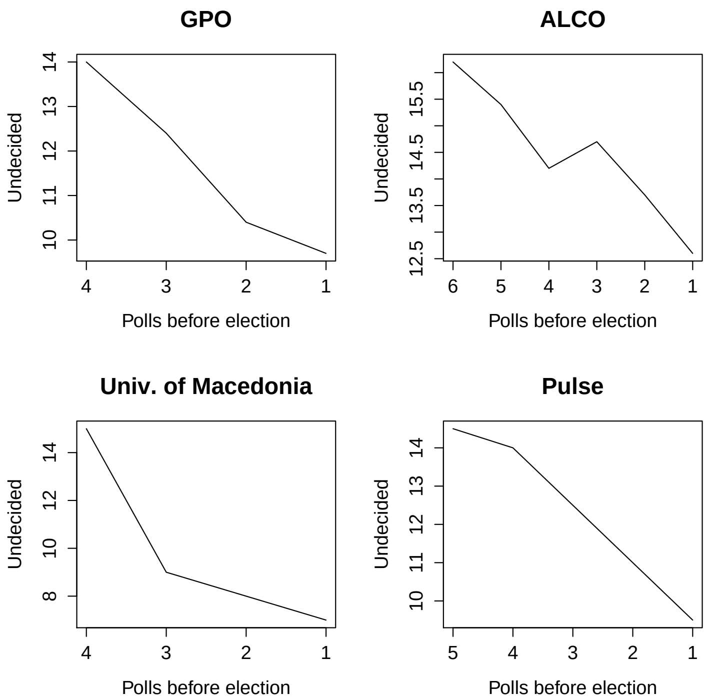

Figure 1: Polling for the 2015 Greek general elections

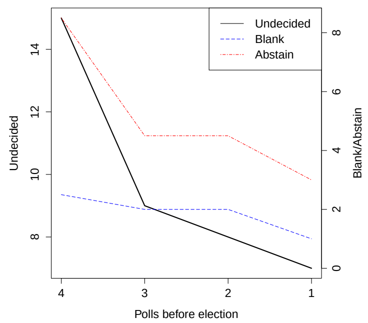

Figure 2: University of Macedonia polls

results for the parties and "undecided" shares, the University of Macedonia first discarded those who indicated they would vote blank or that they would abstain, therefore their "undecided" share includes only those who specifically answered they had not decided yet. However they do report what was the share of original answers that were blanks and abstentions. Figure 2 shows the percentage of the undecided along with the percentage of blanks and abstentions. All graphs tell the same story: the percentage of the undecided voters, in any way we choose to define them, goes down with every single poll as the date of the elections comes closer.

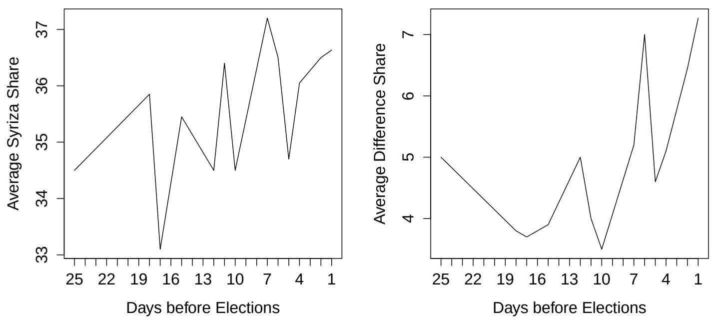

Figure 3: Syriza predicted share

In Figure 3 in the left panel I plot the Syriza expected results of the four polling organizations together. When more than one organizations published results at the same day, I took the average of them. These results show, that abstracting from random noise, there is no monotonic effect of the number of polls on the predicted share of Syriza. This could imply the absence of a pure bandwagon or underdog effect in these elections. At the same time, in the right panel, I plot the difference between the same Syriza shares depicted on the left one, and the ND (the second party in the elections, leaving office) shares. The difference is positive, showing that Syriza was always the frontrunner, but it was not monotonic in the number of polls.

As mentioned in the introduction a finding of the model is that the citizens who are more likely to abstain are mostly the voters who are ideologically more moderate. Using the last wave of the World Value Survey[12] database I will provide some evidence about that. The survey aims to provide insight on the political, social, economic, and in general life attitudes of citizens from 59 countries. To this end, it utilizes an extensive questionnaire.

Using a measure of Undecidedness the interest lies in showing that there is positive correlation between that and being a moderate voter. In particular, the specification to be estimated is the following:

$$Undecided = Center + NeverNational + NeverLocal + NoTrust \qquad (1)$$

Where $Undecided$ is a variable that takes the value 1 if the respondent indicated that, in case there were elections the next day, he either would not know what to vote, he would vote null or blank, or not vote at all, and 0 otherwise. In the survey, Question 95 asks the interviewees to state where they position themselves in the Left-Right political spectrum, giving a number from 1 to 10, with 1 being Left and 10 being Right. The answers to this question constitute the variable $Ideology$. Using the stated $Ideology$ I constructed a series of variables called $Center$ as follows: $Center56$ assigns the value 1 if the respondent declared he places himself on 5 or 6 ($Ideology = 5$ or $Ideology = 6$) and 0 otherwise, and similarly for $Center4567$ and $Center345678$. The variables $NeverNational$ and $NeverLocal$ take the value 1 if the respondent indicated that he never votes in national or local elections respectively and 0 otherwise. $NoTrust$ is a variable that takes the value 1 if the respondent answered that he does not trust political parties in the country and 0 otherwise. $NeverNational$ and $NeverLocal$ are included to control for voters that (according to their own answer) would never vote in elections, no matter who was running. Similarly, $NoTrust$ controls for voters that are in general mistrustful towards parties which can make them vote less. Using the full country data and after dropping observations for which there were no valid answers for the variables examined, there are 53734 observations.

Table 1 depicts the results of the least squares estimations of (1) using the three different $Center$ definitions and with and without Country fixed effects. Country fixed effects are implemented by simply adding a dummy variable for each country, the coefficients of which are not reported in the table for the economy of space. Since these estimations are of linear probability models, the results of columns (1) to (3), are found by employing weighted least squares, using the fitted values of a first step ordinary least squares estimation to construct appropriate weights.[13] The last three columns use a heteroskedasticity-robust variance-covariance matrix for calculating the standard errors because the WLS method was not appropriate.[14] The results of each column tell the same story: voters that never vote in elections are naturally more likely to be Undecided.

More interestingly, the results show that belonging ideologically to the center implies a higher probability of being Undecided. Columns (1) and (4) define the

[12] WORLD VALUES SURVEY Wave 6 2010-2014 OFFICIAL AGGREGATE v.20141107. World Values Survey Association (www.worldvaluessurvey.org). Aggregate File Producer: Asep/JDS, Madrid, SPAIN

[13] More precisely, each model was estimated by OLS first. Then I calculated the estimated standard deviation as follows: $\hat{\sigma}_i = (\hat{y}_i(1-\hat{y}_i))^{1/2}$, provided that $\forall i \ 0 < \hat{y}_i < 1$. Then the WLS estimation was conducted by simply using $1/\hat{\sigma}_i$ as weights.

[14] Since not all fitted values of the initial OLS where such that $0 < \hat{y}_i < 1$

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.078^{***}	0.071^{***}	0.068^{***}	0.136^{***}	0.118^{***}	0.108^{***}
	(0.003)	(0.003)	(0.003)	(0.023)	(0.023)	(0.023)
Center56	0.097^{***}			0.080^{***}		
	(0.004)			(0.003)		
Center4567		0.077^{***}			0.075^{***}	
		(0.003)			(0.003)	
Center345678			0.059^{***}			0.071^{***}
			(0.004)			(0.004)
NeverNational	0.018^{*}	0.017^{*}	0.017^{*}	0.067^{***}	0.066^{***}	0.066^{***}
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
NeverLocal	0.177^{***}	0.180^{***}	0.183^{***}	0.148^{***}	0.150^{***}	0.153^{***}
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
NoTrust	0.108^{***}	0.110^{***}	0.114^{***}	0.057^{***}	0.058^{***}	0.059^{***}
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	53,734	53,734	53,734	53,734	53,734	53,734
Fixed Effects	No	No	No	Country	Country	Country
R^2	0.235	0.234	0.233	0.241	0.240	0.237
Adjusted R^2	0.235	0.234	0.233	0.240	0.239	0.236

Note: *p<0.1; **p<0.05; ***p<0.01 (4)-(6) use heteroskedasticity-robust variance-covariance matrix

Table 1: LS Estimation Results of Specification (1)

center in the strictest way. There we see that being in the center, ceteris paribus, increases the probability of being Undecided by 9.7 and 8 per cent respectively. As the definition of the center is expanded, the effect of being in the center on the probability of being undecided is still positive and significant but falls monotonically. This shows that it is indeed the more ideologically central voters that are more likely to be undecided.

As a robustness check Table 2 provides the coefficients of logit estimations of (1). The results are qualitatively similar to the least squares results. Furthermore, the least squares estimation was conducted after dropping all the countries that are not parliamentary democracies. These results are not reported here, but they are also qualitatively similar to the original least squares ones.

As a further robustness check, I examined the effect of the ideological position on the probability of being undecided using a measure of distance from the center. For this I calculated the variable $Distance_1$ as follows:

$$Distance_1 = \begin{cases} 5 - Ideology & \text{if } Ideology \leq 5 \\ Ideology - 6 & \text{if } Ideology \geq 6 \end{cases}$$

And then I estimated the following specification:

$$Undecided = Distance + Distance^2 + NeverNational + NeverLocal + NoTrust. \quad (2)$$

In Specification 2 the square of $Distance_1$ is included so as to capture the effects of the ideological distance that are potentially non-linear. The results of the estimation of this specification are reported on Table 3. The results show that an increase in the ideological distance from the center (positions 5 and 6), results in a decrease in the probability of being undecided, albeit in a decreasing way.

	(1)	(2)	(3)
Constant	-2.293***	-2.350***	-2.355***
	(0.027)	(0.029)	(0.033)
Center56	0.588***		
	(0.021)		
Center4567		0.503***	
		(0.023)	
Center345678			0.399***
			(0.027)
NeverNational	0.160***	0.149***	0.149***
	(0.042)	(0.042)	(0.042)
NeverLocal	0.859***	0.878***	0.892***
	(0.042)	(0.042)	(0.042)
NoTrust	0.785***	0.793***	0.804***
	(0.027)	(0.027)	(0.027)
Observations	53,734	53,734	53,734
Log Likelihood	-26,871.970	-26,997.450	-27,137.050
Akaike Inf. Crit.	53,753.930	54,004.890	54,284.100
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 2: Logit Estimation Results of Specification (1)

	(1)	(2)
Constant	0.175***	-1.705***
	(0.004)	(0.027)
Distance	-0.088***	-0.579***
	(0.004)	(0.026)
Distance^2	0.016***	0.112***
	(0.001)	(0.007)
NeverNational	0.017**	0.160***
	(0.008)	(0.042)
NeverLocal	0.178***	0.859***
	(0.008)	(0.043)
NoTrust	0.106***	0.784***
	(0.003)	(0.027)
Method	WLS	Logit
Observations	53,734	53,734
R^2	0.234	
Adjusted R^2	0.234	
Log Likelihood		-26,845.590
Akaike Inf. Crit.		53,703.180
Residual Std. Error	1.010 (df = 53728)	
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 3: Results of Specification (2)

The preceding analysis shows that, controlling for other variables, there is a positive relationship between having a centrist ideology and being undecided. However, since it has been based on aggregate data, I will analyze a few cases to see how it works in the country level. For this illustration purposes I chose

Sweden, Spain, Estonia and Greece.[15] In addition, for the individual country cases I also defined $Distance_2$ to measure the distance from the country median:

$$Distance_2 = |Ideology - median(Ideology)|.$$

The country specific regression result tables are found in the Appendix are The first country to analyze is Sweden. A simple correlation coefficient between $Undecided$ and the two measures of the distance is: -0.22 and -0.24 respectively. The regression results for Sweden are presented in Tables 7 and 8.

Since the median Ideology in Sweden is equal to 5, I have included alternative specifications of the $Center$ variables: $Center5$, $center456$ and $Center34567$. The Swedish results are consistent with the aggregate findings, with the only difference that $NeverNational$ does not seem to play a significant role in the probability of someone being Undecided and the same holds for $NoTrust$. Dropping $NoTrust$ does not result in different qualitative results. Both distance specifications have the correct negative sign, meaning that moving away from the center decreases the probability of being undecided.

As for the Spanish results, the simple correlation between $Undecided$ and the two distance measures is: -0.23 and -0.30. Tables 9 and 10 are also consistent with the aggregate: being in the center implies a higher probability of being undecided.

The two countries analyzed so far are consistent with the aggregate results. For comparison, I include the results of Estonia (Tables 11 and 12), where being in the center has apparently no predictive power over the probability of being Undecided. The simple correlation between $Undecided$ and the two distance measures is: -0.03 and -0.04.

The last country to analyze is Greece, which unfortunately was not included in the last wave of the World Values Survey so for this reason I had to use the European Values Study of 2008.[16] Although the two surveys examine similar issues, the datasets are a little different. For example, in the EVS there are no questions regarding the frequency of participation in elections. Therefore, the variables $NeverNational$ and $NeverLocal$ cannot be used. The variables that have to do with center and $Trust$ are defined in the same way. The variable $NoInterest$ is a dummy variable that takes the value 1 if the respondent indicated that he is not very interested or not at all interested in politics. A final important, for our purposes, difference between the two is how the variable $Undecided$ is constructed. In the WVS the relevant question asked what the interviewees would vote, if there were elections the next day. On the other hand, in the EVS there are three questions examining this. First, question 263 asks whether the interviewee would vote, had there been elections the next day. If the interviewee would answer "yes" then question 264 asks what they would vote. If the interviewee would asnwer "no" to question 263 then question 264 would be skipped and the interviewer would ask question 265: "which party appeals to you the most". In this case, I coded as Undecided those who in question 263 stated that they would not vote at all, those who stated they did

[15] Other countries that were analyzed but whose results are not reported to save space are Australia, Germany, New Zealand, Poland, Slovenia and South Africa. The first four of which give consistent results with the aggregate.

[16] EVS (2011): European Values Study 2008: Integrated Dataset (EVS 2008). GESIS Data Archive, Cologne. ZA4800 Data file Version 3.0.0, doi:10.4232/1.11004

not know whether they would vote and those who gave no answer or answered "I don't know" to question 264. Table 13 is consistent to the previous findings.

From the table we see that $Center5$ itself is not statistically significant but all the other $Center$ variables are. Dropping $NoTrust$ does not change the results. The results of Greece for the distance specifications are in Table 14.

Distance as defined with the variable $Distance_1$ is significant but not $Distance_2$. Moving away from ideological positions 5 and 6, results in a decrease in the probability of being undecided by 4.9 per cent. The simple correlation between $Undecided$ and the measures of distance is: -0.13 -0.12. The results for Greece, although not as clear-cut as for Sweden or Spain, show that there is a positive relationship between being ideologically in the Center and being undecided.

The conclusion of this section is that there seems to be a positive relationship between being ideologically in the center and being undecided, although this finding is obviously not universal. At the same time, the example of Greece, shows the correlation of the number of polls have and the undecided vote: more polls imply less undecided voters, since with every poll the share of respondents that did not declare any party as the one they were going to vote was decreasing. Furthermore, the polls have a non-monotonic effect on the share of the winning party and at the same time on the difference between the winning party and its contender. The theoretical model that will be presented next is able to accommodate these findings.

3 Model Description

The model builds upon and expands the model of Ortuño Ortín [1999]. There is a uni-dimensional policy instrument that can take values in $D = [-\eta, 1+\theta] \subset \Re$ with both η and θ positive. The voters have single-peaked preferences over this policy space and their optimal policies are distributed over D according to a distribution function $F(\cdot)$ which is assumed to be continuous, strictly increasing and differentiable with a corresponding density function $f(\cdot)$. The utility of the voter y from the implemented policy x is given by the function $-u(|x-y|)$, ie. it is a function of the absolute distance of the voter's optimal policy y an the implemented policy x. Function $-u(|x-y|)$ is decreasing in $|x-y|$ and it has a unique maximum at $x = y$ such that $-u(0) = 0$. These mean that the utility function of a voter is symmetric around his optimal policy point where the utility is maximum and normalized to zero. We will be identifying voters with their optimal policy, ie., voter x_i is the voter that has optimal policy x_i. There are two parties running in the elections, L and R each having a fixed position in 0 and 1 respectively. The actual implemented policy will be the linear combination of the two policies using the parties' shares in the elections as weights:

$$x = p_L \times 0 + (1 - p_L) \times 1 = 1 - p_L,$$

where p_L is the share of votes party L gets, defined as $p_L = \frac{m_L}{m_L+m_R}$, with m_L and m_R being the voter masses that voted for L and R respectively, meaning that the parties' shares are calculated over the mass of voters that actually voted. If u is the mass of the citizens that decide not to vote then $m_L + m_R + u = 1$.

In a proportional representation system, increasing the votes cast for a party increases its number of seats and its political power. Given this, voters know that their votes will move the share of a party up or down, and as a result, the implemented policy left or right. If some voters expect the implemented policy to be, for example, too much to their left they will want to vote for R. We can think of the voters each deciding what vote to cast in order to bring the implemented policy as close to them as possible in a similar way as in Alesina and Rosenthal [1996]. For this reason, each voter would like to know how the other voters are behaving before he chooses which party to vote for. For example, even though the voter might be ideologically closer to a party, if he expects too many people to vote this party, he might want to vote for the other one. Consider Table 4 where I analyze the decision of a voter located at 0.4. This voter is closer to 0 than to 1, and as such he identifies with L more than R. However, the decision of what to vote depends on what others will do.

L share	Implemented policy	Decision
0.8	0.2	R
0.3	0.7	L

Table 4: Decision of a voter at 0.4

3.1 Regret Minimization

The second feature of voters' behavior is regret minimization: they do not want to vote for a party and then end up regretting that decision, which means, as mentioned already, that a voter wants to avoid at all costs the situation where he would have voted for party L (R), but then elections results would reveal to him that he should had voted for party R (L). In this setting regret minimization is modeled using the *minimax* decision rule. If the preference distribution is not known, some voters will need some additional information before they decide which party to vote for. This information will come in the form of polls. The combination of regret minimization and lack of adequate information will result in voters being *undecided* about what to vote.

In this model, an Undecided voter is a voter that cannot assign a probability to any of the following states of the world after the elections: i) the implemented policy being to his left, ii) the implemented policy being to his right and iii) the implemented policy being exactly on the voter's optimal position.

The undecided voter cannot assign probabilities but he can calculate utilities from each state of the world, given his action, which he assumes that will have an influence on the result. In what follows $U_i^\omega(S)$ represents the utility of voter x_i, under state of the world ω, after he had chosen S, with $S \in \{L, R, A\}$. L represents voting for the left party, R voting for the right party and A represents the choice to abstain and not vote for either of the parties. The first state of the world, $\omega = 1$ corresponds to the case that, given everyone else's choice, the implemented policy will be to the right of the voter, $\omega = 2$ corresponds to the state of the world that the implemented policy will be to his left, and $\omega = 3$ to the one that the implemented policy falls exactly on his position.

Table 5 shows the ranking of utilities for each state of the world. In the first state of the world voting for L is the best choice because this vote brings the implemented policy a little closer to him. On the contrary, voting for R would be the worst possible choice because it would push the implemented policy away

	State of World	Utilities
$x_i < x$	1	$U_i^1(L) \geq U_i^1(A) \geq U_i^1(R)$
$x_i > x$	2	$U_i^2(R) \geq U_i^2(A) \geq U_i^2(L)$
$x_i = x$	3	$U_i^3(A) \geq U_i^3(L) = U_i^3(R)$

Table 5: Ranking of utilities

from him. The utility from abstaining falls between the two because it does not move the implemented policy either left or right. The argument for the second state of the world is similar. Finally, in the third state of the world abstaining is the best choice. We can now construct a table of regrets for each action, with regret being defined as the highest possible attainable utility level in each state of the world minus the actual utility level delivered by an action.

	State of World	Regret of L	Regret of R	Regret of A
$x_i < x$	1	0	$U_i^1(L) - U_i^1(R)$	$U_i^1(L) - U_i^1(A)$
$x_i > x$	2	$U_i^2(R) - U_i^2(L)$	0	$U_i^2(R) - U_i^2(A)$
$x_i = x$	3	$U_i^3(A) - U_i^3(L)$	$U_i^3(A) - U_i^3(R)$	0

Table 6: Regret Table

Given a turnout, the fact that the implemented policy is a convex combination of the two parties' fixed policies implies that a citizens vote for L or for R will move the implemented policy by the same distance, in all states of the world. Therefore, from Table 6 we see that the maximum regret from choosing L is $U_i^2(R)-U_i^2(L)$ and the maximum regret from choosing R is $U_i^1(L)-U_i^1(R)$. The maximum regret from abstaining is $U_i^1(L) - U_i^1(A) = U_i^2(R) - U_i^2(A)$. Notice that $U_i^2(R)-U_i^2(L) \geq U_i^2(R)-U_i^2(A)$ therefore voting L cannot be minimizing maximum regret. Similarly since $U_i^1(L) - U_i^1(R) \geq U_i^1(L) - U_i^1(A)$ voting R cannot be minimizing maximum regret. Therefore, abstaining is the choice that minimizes maximum regret.

It is interesting to point out that minimax regret is not the only decision criterion under uncertainty that returns A as the optimal choice of the undecided voters. We get the same result if we use Wald's or Hurwicz's criterion.

If a voter is undecided at the time of the elections then he will simply stay at home and not vote at all, and this is something that the rest of the voters have to take into account. In the case of incomplete information, which means in our case unknown distribution of voters, some partial information will be released through opinion polls. A poll at time t reflects how the electorate would actually vote, had there been elections at that same time t. It is assumed that the voters respond truthfully to polls. In particular the poll results are condensed into two variables: the mass of voters that would vote for party L and the mass of voters that were still undecided at the time of the poll. Some voters -the less moderate ones- will have adequate information to make a decision, and this is how the polls come into play: every poll's information influences the decision of the less moderate undecided voters, but this information can only be known to the voters through the next poll (if one takes place) or the elections.

3.2 Complete information equilibrium

If the distribution function of the citizens' optimal points $F(\cdot)$ were known to them then the regret minimization behavior would not matter, and the only driving force behind voting would be the optimal policies of the voters. In this complete information case the set of pure strategies for a voter $x_i \in D$ is $S = \{L, R\}$ with L and R representing him voting for the left and right party respectively. Since the implemented policy depends on the shares each party gets, voters strategies are not independent from what the other voters will do. If a voter thinks that the implemented policy will be too much on the left he may want to vote for the right, and if he thinks the implemented policy will be too much on the right he may want to vote for the left. A voter's strategy is a function $\sigma_{x_i} : S \to [0,1]$ that assigns a probability of voting for L given the position of the voter. I define as $x(\sigma)$ the implemented policy that results from strategy profile $\sigma = (\sigma_{x_i})_{x_i \in D}$.

We are now ready to define the complete information voting equilibrium.

Definition 1. *Strategy profile σ constitutes a Complete Information Voting Equilibrium if:*

- *if $x_i < x(\sigma)$ then $\sigma_{x_i} = 1$,*
- *if $x_i > x(\sigma)$ then $\sigma_{x_i} = 0$,*
- *and if $x_i = x(\sigma)$ then $\sigma_{x_i} = 0.5$.*

The equilibrium concept can be shown to be equivalent to the Strong Nash Equilibrium (Gerber and Ortuño Ortín [1998] and Ortuño Ortín [1999]).

The equilibrium defines a cut-off point $x(\sigma)$ that divides the electorate in two parts: one that vote for L that are to the left of it, and the one that vote for R. The theorem that follows establishes the existence and uniqueness of this cut-off.

Theorem 1. *There always exists a unique Complete Information Voting Equilibrium σ^* characterized by the cut-off point $x^* = 1 - F(x^*)$.*

Proof. By continuity of $F(\cdot)$ the point x^* exists, and by strict monotonicity this point is unique. Now, let x^* be the implemented policy. Then strategy profile σ^* implies that the voters who choose L are the ones to the left of x^* and the ones that choose R are those to the right of x^*, with masses $F(x^*)$ and $1 - F(x^*)$ respectively. In turn, these masses give rise to the the implemented policy $x^* = 1 \times F(x^*) + 0 \times (1 - F(x^*)) = 1 - F(x^*)$, which proves that an equilibrium always exists, and since x^* is unique there is only one equilibrium defined by $x^* = 1 - F(x^*)$.

The last step is to show that there is no other equilibrium. Suppose that there is an equilibrium implemented policy $x' \neq x^*$. The equilibrium strategy implies that everybody to the left of x' vote for L and the rest vote for R, giving rise to the implemented policy $x'' = 1 - F(x')$, but we have that $x'' \neq x'$, which leads to a contradiction. □

Given their optimal policy points voters want to cast their vote in a way that will bring the implemented policy as close to their optimal point as possible, given the strategies of the other voters. There cannot be a situation in equilibrium where there exist some voters with optimal policy to the left of x^* who voted for R; if these voters would switch their vote, the implemented policy would be closer to their optimal one. Note that the equilibrium would be the same had we had expanded the strategy set to include the possibility of abstention. Another interesting thing to notice is that $x^* = 1 - F(x^*)$ does not necessarily correspond to the median voter x^M; the model does not in general converge to the median voter. The only case such that we have $x^* = x^M$ is when $x^M = 1/2$.

3.3 Information Acquisition

When the distribution of voters is common knowledge, then the voters can calculate $x^* = 1 - F(x^*)$ and infer what they should vote. However, when the distribution is no longer known to the voters, then some of them do not have enough information to decide what to vote, because the regret minimization behavior comes into play.

A voter will be sure of what to vote if the interval where the future implemented policy will fall does not include his optimal policy. Therefore, since the implemented policy $x = 1 - p_L$ can never fall outside of $[0, 1]$, it is easy to see that the voters to the left of 0 would never want to vote for R. For all of them the state of the world for which $x_i < x$ happens with probability one: they know for sure that the implemented policy will fall to their right. By voting for L, p_L increases and x comes closer to 0. Voting R on the other hand, decreases p_L and x gets closer to 1. Obviously out of these two outcomes, it's the first one that the voters in $[-\eta, 0)$ prefer, so they will vote for L. Similarly, voters to the right of 1 would vote for R. I will call voters in $[-\eta, 0)$ as *left partizans* and voters in $(1, 1 + \theta]$ *right partizans*. When referring to both left and right partizans I will simply use *partizans*. The rest of the voters, the ones in $[0, 1]$, are the initially undecided voters who will need some information from the polls to help them figure out what to do.

An undecided voter knows that the future implemented policy will be somewhere in [0,1] but he doesn't know where exactly. It can fall to the right of, to the left of or exactly on his optimal point, therefore it's not clear to him which party he should vote for, so according to the minimax regret motive he will abstain. Consider again a voter with the optimal point at 0.4. If this voter votes for L but the elections result in an implemented policy of $x = 0.1$ then this voter will regret his decision: he should had voted for R, since voting for L actually moved the implemented policy away from his optimal point.

In the introduction of this section it was mentioned that voters are assumed to be responding truthfully to polls which I believe is a mild assumption, as it is not clear what a voter would gain by lying. In this setting truthful responding means that the voters are treating polls like they were real elections and they are using the information from the polls to make a new decision. This decision is not connected at all to the number of future polls because even if the voters knew how many polls will be before some elections their behavior would not change. Therefore, when we examine the behavior of the agents after the results of the k-th poll has been announced, we are analyzing what would be the equilibrium of the voting game had there been elections right after the announcement of this k-th poll results. Since it is assumed that voters respond truthfully in polls, this equilibrium also expresses how the voters would respond if instead of elections right after the k-th poll we had a new poll. For this reason, when I refer to voting for a party, this can either mean voting in the actual elections or "voting" in a poll. The only relevant information the citizens need to vote in a poll or in the elections is the information on the electorate given by the previous poll.[17]

Each poll can provide the undecided voters with two pieces of information: the mass of the voters that will vote for party L, and the mass of the undecided voters at the time of the poll. Using this information they can calculate the two most extreme cases, the maximum possible implemented policy which is defined as x_R and the minimum possible one, defined as x_L. The way to find these two is to see what would be the implemented policy if all the currently undecided would vote for L and what would it be if all the undecided would vote for R.

Since the mass of the voters who have made up their mind consists of the partisan voters and the formerly undecided that are now absolutely sure of what to vote, this mass of voters forms a lower bound for the mass of total voters the party will get in the future. Therefore an undecided voter that reads the poll results and sees that the mass of voters that are going to vote for party L is m_L and the mass of the undecided is, say, u, can infer a few other things. First, that the mass of voters that are going to vote for party R is at least $1 - m_L - u$. Second, that the vote share that party L can get at this point is at most $\frac{m_L+u}{m_L+u+(1-m_L-u)} = m_L + u$ and similarly that the share of votes that R can get is at most $1 - m_L$. Third, using $m_L + u$ and $1 - m_L$ he can infer the potential implemented policies after each of these two most extreme results: $x_L = 1 - m_L - u$ and $x_R = 1 - m_L$.

A voter that is to the left of x_L would never vote for party R. He knows that the possible implemented policy cannot ever be closer to him than x_L. But since x_L is already to his right he would never vote for R because this way he would regret his decision with certainty. Therefore he votes for L. Similarly every voter to the right of x_R votes for party R. The voters that are located in $[x_L, x_R]$ remain undecided. I will use $[x_L^k, x_R^k]$ to indicate the interval of the undecided voters after k polls, with $x_L^0 = 0$ and $x_R^0 = 1$. Note also that

$$x_L^k \geq x_L^{k-1} \text{ and } x_R^k \leq x_R^{k-1}, \forall k \in \mathbb{N}. \tag{3}$$

This means that once uncertainty has been cleared for some undecided voters it never comes back, which is a direct consequence of the regret minimization behavior. Furthermore,

$$p_L^k = \frac{F(x_L^k)}{F(x_L^k) + 1 - F(x_R^k)} \tag{4}$$

is the percentage party L would get if there were elections right after k polls.

After k polls, voters in $[x_L^k, x_R^k]$ are called undecided at time k, voters in $[-\eta, x_L^k)$ are called L voters at time k, and voters in $(x_R^k, 1+\theta]$ are called R voters at time k. The set of voters at time k, D^k, is defined as the union of the two sets of voters: $D^k = [-\eta, x_L^k] \cup [x_R^k, 1+\theta]$.

Since the agents no longer know the distribution of preferences, the strategy space of each voter is expanded to include the possibility of abstaining therefore

[17] With the exception of the case where no poll took place. In this case, as it will be shown later, the relevant information is given by the fixed positions of the parties.

$S = \{L, R, A\}$ with a voter's strategy after k polls $\sigma^k_{x_i} \in S$. At the same time the equilibrium should specify the time it refers to. Each voter simultaneously decides whether to abstain or vote for L or R. At time k according to the minimax regret decision rule, the undecided at time k prefer to abstain.

Definition 2. *After k polls strategy profile $\sigma^k = (\sigma^k_{x_i})_{x_i \in D}$ is a Voting Equilibrium with Regret if:*

- *if $x < x^k_L(\sigma)$ then $\sigma^k_x = L$,*
- *if $x > x^k_R(\sigma)$ then $\sigma^k_x = R$,*
- *and if otherwise then $\sigma^k_x = A$.*

The two cut-off points $x^k_L(\sigma)$ and $x^k_R(\sigma)$ define three regions of voters: the L voters, the undecided and the R voters. After every poll the citizens calculate the new regions that the implemented policy can fall into and adjust their strategies accordingly.

Theorem 2. *Under incomplete information and after $k \in \mathbb{N}_0$ polls, there always exists a unique equilibrium σ^{k*} characterized by the cut-off points $x^0_L = 0$ and $x^0_R = 1$ for $k = 0$, and $x^k_L = 1 - F(x^{k-1}_R)$ and $x^k_R = 1 - F(x^{k-1}_L)$ for $k > 0$.*

Proof. Consider the $k > 0$ case first. By continuity and strict monotonicity of $F(\cdot)$ we have that x^k_L and x^k_R exist and are unique. Given x^{k-1}_L and x^{k-1}_R, citizens calculate $x^k_L = 0 \times F(x^{k-1}_R) + 1 \times (1 - F(x^{k-1}_R)) = 1 - F(x^{k-1}_R)$, the lowest point the implemented policy can be in the future. Similarly they calculate x^k_R. Therefore, $\forall x \in [x^k_L, x^k_R]$, $\sigma^k_x = A$. For $x \in [-\eta, x^k_L)$ we have $\sigma^k_x = L$, and for $x \in (x^k_R, 1 + \theta]$ we have $\sigma^k_x = R$. No voter has an incentive to deviate from this behavior. For $k = 0$ the argument is identical, with the difference that $x^0_L = 0$ and $x^0_R = 1$ since with no polls conducted, the citizens know that the implemented policy will have to fall into $[0, 1]$. □

Note that if $x^k_L = x^k_R$ we are simply in the full information case. The preceding theorem defines a sequence of voting equilibria, one for every k. In the first poll, only the partizans declare their preference, the voters in $[0, 1]$ are undecided. When the first poll is published the masses of the partizans are revealed, and with them an updated pair of minimum and maximum possible implemented policies. In the second poll, the partizans declare their preference but now also some of the undecided have made up their mind. When the second poll is published the new voting masses are declared and so on. This mechanism means that the x^k_L and x^k_R are governed by the following system of equations:

$$x^k_L = 1 - F(x^{k-1}_R) \tag{5}$$

$$x^k_R = 1 - F(x^{k-1}_L),$$

If after a number of polls s with each subsequent poll the interval of the undecided does not change, then the process has reached a steady state where $x^s_L = x^{s+t}_L = x^*_L$ and $x^s_R = x^{s+t}_R = x^*_R$, $t \geq 1$. Plugging the expression for x^{k-1}_R into the expression for x^k_L we get:

$$x^k_L = 1 - F(1 - F(x^{k-2}_L)). \tag{6}$$

This is a second order difference equation with initial values $x_L^0 = 0$ and $x_L^1 = 1 - F(x_R^0) = 1 - F(1)$.

Next, we will establish sufficient conditions for the sequence of polls to result in complete information.

Theorem 3. *If $F'(1 - F(x))F'(x) < 1$ $\forall x \in [0, 1]$ then a sequence of polls will lead to the complete information outcome.*

The theorem will be proved through the following three propositions.

Proposition 1. *The complete information outcome is a fixed point of function $h(x) = 1 - F(1 - F(x))$, $x \in [0, 1]$.*

Proof. This function is continuous as it is the composition of two continuous functions, it is strictly increasing and its range is a proper subset of $[0, 1]$ therefore it has a fixed point in that subset. Suppose that time s is the first time we observe $x_L^s = x_R^s$. Then the mass of undecided voters becomes 0, and we have: $x_L^{s+1} = \frac{F(x_L^s)+0}{F(x_L^s)+0+1-F(x_R^s)} \times 0 + (\frac{1-F(x_r^s)}{F(x_L^s)+0+1-F(x_R^s)}) \times 1 = 1 - F(x_R^s)$. Similarly $x_R^{s+1} = 1 - F(x_R^s)$, showing that $x_L^{s+1} = x_R^{s+1}$. We also know that $x_L^{s+1} \geq x_L^s$ and $x_R^{s+1} \leq x_R^s$. Combining the two last inequalities together we get that: $x_L^{s+1} \geq x_L^s = x_R^s \geq x_R^{s+1}$. But we have already shown that $x_L^{s+1} = x_R^{s+1}$, therefore we have to have: $x_L^{s+1} = x_L^s$ and $x_R^{s+1} = x_R^s$. □

We have established existence of a fixed point of $h(\cdot)$, and we know that one of the fixed points will always be the *complete information* outcome: once it is reached all voters have made up their mind and are not going to change it. Therefore, if $h(\cdot)$ has a unique fixed point, it will be the complete information outcome. Uniqueness is not guaranteed however, and depends on the form of the distribution function $F(\cdot)$.

Proposition 2. *If $F'(1 - F(x))F'(x) < 1$ $\forall x \in [0, 1]$ then $h(\cdot)$ has a unique fixed point.*

Proof. Assume that there are two fixed points, x^* and x^{**} and that, without loss of generality, $x^* < x^{**}$, then by the Mean Value Theorem, there exists a $d \in (x^*, x^{**}) \subset (0, 1)$ such that

$$h'(d) = \frac{h(x^{**}) - h(x^*)}{x^{**} - x^*} = \frac{x^{**} - x^*}{x^{**} - x^*} = 1,$$

so

$$F'(1 - F(d))F'(d) = 1.$$

At the same time, since $h(0) > 0$ then $h(\cdot)$, crosses x^* from above then it has to be the case that it crosses x^{**} from below implying that there are points close to x^{**} for which $F'(1 - F(x))F'(x) > 1$, which concludes the contradiction. □

The last proposition establishes when the sequence of polls will converge to a fixed point.

Proposition 3. *Let $\underline{x}^*$ be the smallest fixed point of $h(\cdot)$. If $F'(1-F(x))F'(x) < 1$ holds in $[0, \underline{x}^*]$ then it is a sufficient condition for x_L^k to converge to $\underline{x}^*$.*

Proof. Define the sequence $\{a_n\}_{n=0}^{\infty}$ with $a_n \equiv \underline{x}^* - x^n$. Now, let $x^0 \in [0, \underline{x}^*)$ and $x^1 \in (x^0, \underline{x}^*)$ and note that $\underline{x}^* - x^n = h(\underline{x}^*) - h(x^{n-2})$. Then, by the Mean Value Theorem, there exists $d^{n-2} \in (x^{n-2}, \underline{x}^*) \subset (0,1)$ such that:

$$h'(d^{n-2}) = \frac{h(\underline{x}^*) - h(x^{n-2})}{\underline{x}^* - x^{n-2}},$$

and therefore

$$h(\underline{x}^*) - h(x^{n-2}) = h'(d^{n-2})(\underline{x}^* - x^{n-2}).$$

or

$$\underline{x}^* - x^n = h'(d^{n-2})(\underline{x}^* - x^{n-2}),$$

so since $F'(1 - F(x))F'(x) < 1$ there exists a $K \in (0,1)$ such that:

$$\underline{x}^* - x^n \leq K(\underline{x}^* - x^{n-2}) \leq K(K(\underline{x}^* - x^{n-4}))$$

which by repeated substitution becomes:

$$\underline{x}^* - x^n \leq \begin{cases} K^{\frac{n}{2}}(\underline{x}^* - x^0), & n \quad even \\ K^{\frac{n-1}{2}}(\underline{x}^* - x^1), & n \quad odd \end{cases}$$

Splitting $\{a_n\}_{n=0}^{\infty}$ into two subsequences, one that has the odd-numbered elements and another that has the even-numbered ones, we see that each subsequence goes to zero, therefore since the two covering subsequences go to zero $\{a_n\}_{n=0}^{\infty}$ also goes to zero, which implies that

$$\lim_{n \to \infty} x^n = \underline{x}^*.$$

□

Therefore, if $F'(1 - F(x))F'(x) < 1$ holds in $[0,1]$ then the complete information outcome is a unique fixed point of $h(\cdot)$, and a sequence of possibly infinite polls will converge to it. In absence of fixed point uniqueness Proposition 3 also tells us that if there is a fixed point $\underline{x}^*$ such that $\underline{x}^* < x^*$ with x^* being the fixed point corresponding to the complete information outcome, and if $F'(1 - F(x))F'(x) < 1$ is satisfied in the interval $[0, \underline{x}^*]$, then we will have a mass of undecided voters located in $[\underline{x}^*, \bar{x}^*]$, with $\bar{x}^* = 1 - F(\underline{x}^*)$. In this case, the polls cannot lead to *complete information*, and there will always be some positive mass of undecided voters in $[\underline{x}^*, \bar{x}^*]$, no matter how many polls will be conducted afterwards. Notice that this means that if a poll shows exactly the same results like the previous one, then every citizen will know with certainty what will be the results of the election and what will be the abstention rate. The voters in $[\underline{x}^*, \bar{x}^*]$ will still not vote because they cannot know how the outcome of the elections will change given that they themselves will vote.

Inequality $F'(1 - F(x))F'(x) < 1$ may seem a little strange; however it can be intuitively explained in the case of a symmetric distribution of the undecided at period 0. It provides a sort of upper bound of the the maximum of the probability density function, or putting it differently, an implicit lower limit on the variance of the distribution. When most of the mass of the undecided is located close to the mean of the distribution, their influence in the elections is potentially so large that there can be no improvement in information in the sense of having less undecided citizens.

To illustrate the insight of Theorem 3, I provide a couple of examples with different citizen preference distributions. First, assuming that the distribution is uniform, we have that:

$$F'(1 - F(x))F'(x) = \frac{1}{(1 + \theta + \eta)^2}. \tag{7}$$

Given $\theta + \eta > 0$, then $\frac{1}{(1+\theta+\eta)^2} < 1$, therefore the sufficient condition for uniqueness and convergence hold for all $x \in [0, 1]$. On the other hand, an extreme case when the condition fails is provided by a symmetric triangle distribution with small masses of partizan voters. In fact, a simple numerical application shows that for $\eta = 0.05$ and $\theta = 0.07$ and the triangle distribution, polls cannot improve the information since at least 98.5 per cent of the voters in $[0, 1]$ will remain undecided. In the next section I will provide further examples of distributions for which the minimum undecided mass can be between these two extremes examined here.

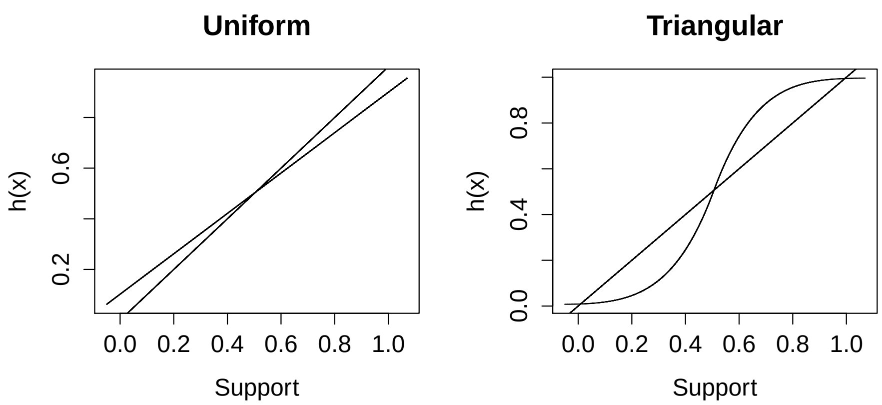

Figure 4: Examples of h(x)

Figure 4 shows the plots of the $h(\cdot)$ function for the two cases mentioned above. In the uniform case, there exists only the fixed point corresponding to the complete information outcome, therefore, with enough polls, it can be achieved. On the contrary, in the triangular distribution case, we can see that there are three fixed points: the complete information one in the middle, the left one where x_L^k converges to, and the third one, which corresponds to the point x_R^k would converge to. It is easy to see that the condition for x_L^k to converge to the complete information outcome does not in fact hold. The two non-middle fixed points define the interval where the minimum possible mass of undecided citizens is located on.

In the Appendix, I examine an extension of the model analyzed here that allows for some day-to-day political noise that can shift the ideological position of the citizens to the left or the right. The only significant difference is that in this case the polls can never help reach the complete information outcome, so there will always be some undecided voters.

4 Implemented Policy and Citizen Welfare

In this section I will discuss the influence of polls on implemented policy and on citizen welfare. Recall that citizens respond truthfully to polls, treating them like actual elections, and that the results of, say, the third poll, are equivalent to the results we would get in an election if there had been only two polls conducted before them. After each poll we have a potential implemented policy defined as follows:

$$x^k = 1 - p_L^k = 1 - \frac{F(x_L^k)}{F(x_L^k) + 1 - F(x_R^k)}$$

or

$$x^k = \frac{1 - F(x_R^k)}{F(x_L^k) + 1 - F(x_R^k)}. \tag{8}$$

Comparing x^k with x^{k+1} we see that the implemented policy sequence behaves in the following way: if

$$\frac{F(x_L^k)}{F(x_L^{k+1})} \geq \frac{1 - F(x_R^k)}{1 - F(x_R^{k+1})} \tag{9}$$

then $x^{k+1} \geq x^k$, and if (9) has the opposite direction then $x^{k+1} \leq x^k$. Equality holds when we reach a fixed point of $h(\cdot)$. Intuitively this inequality tells us that the implemented policy moves to the right when the formerly undecided voters that decide to vote for the right are greater than the ones that decide to vote for the left. If the conditions for the complete information outcome hold then x^k will converge to it.

Social welfare takes the form of a simple utilitarian function:

$$W(x) = \int_{-\eta}^{1+\theta} -u(|x - y|)dF(y) \tag{10}$$

with x being the implemented policy and and y being the optimal policies of each citizen. Recall that x^k is the implemented policy we would have if there were elections right after the k-th poll. Using x^k in $W(\cdot)$ we find the social welfare that would be obtained from implemented policy x^k. In the case of linear utility $u(|x - y|) = |x - y|$, the welfare function is strictly concave in x as long as $f(x) > 0$ for all $x \in D$, and it has a maximum at the point x^M that satisfies:

$$\frac{1}{2} = F(x^M)$$

ie., at the median citizen. For $-u(|x - y|)$ strictly concave in x it is easy to see that this welfare function is also strictly concave in x but its maximum will generally not correspond to the median citizen. For instance, in the quadratic case, the maximum occurs at the mean of the distribution. Focusing on the linear utility case, the welfare is increasing as the implemented policy is getting closer to the median citizen and decreasing when the implemented policy moves away from him. A first, trivial thing to notice is that in case of complete symmetry, that is $\eta = \theta$ and symmetric distribution, the implemented policy will stay at 0.5, resulting in the maximum welfare possible, no matter the number of polls and no matter the mass of the undecided because with each poll each party gets the exact same mass of voters and they start with the same mass of partizans.

The fact that the welfare is strictly concave in the implemented policy can help us analyze the social welfare using the levels of the implemented policy rather than the levels of the welfare itself. In particular, if the density function is symmetric around the median, then welfare is a strictly increasing function of the distance of the implemented policy from the median voter.[18] Take the case of a uniform distribution of the voters and without loss of generality assume that $\eta > \theta$ (since we have already discussed what happens in case of symmetric distribution and $\eta = \theta$ in the end of the previous section), an example of which, with $\eta = 0.07$ and $\theta = 0.05$ is depicted in Figure 5.

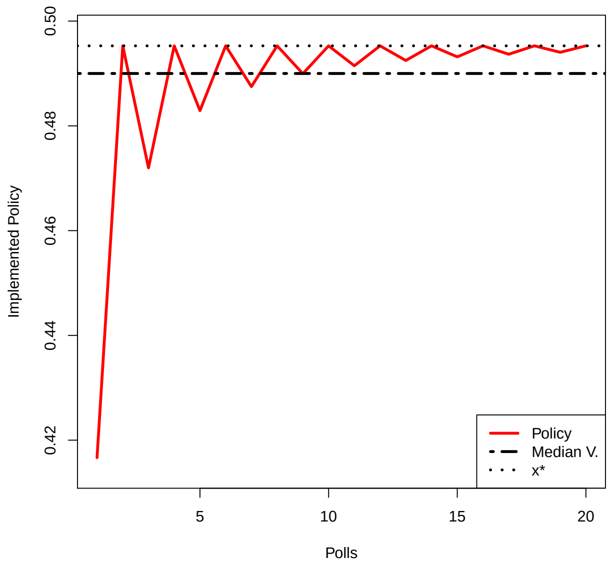

Figure 5: Uniform distribution example

This figure shows how the implemented policy moves with every poll, and how far the implemented policy is from the median voter and the complete information outcome x^*. It's easy to see that neither the implemented policy nor the distance to the median are monotonic in the number of polls. In fact there are polls that are welfare reducing: the second poll is particularly bad, taking the implemented policy away from the median voter but also away from the complete information outcome. We have already seen that with the uniform distribution the complete information outcome can be reached. However this example shows that more polls are not always better from a social point of view.

For the next two examples I will focus on a left-skewed distribution, in particular the Beta distribution with parameters $\alpha = 1.4$ and $\beta = 1.1$. In

[18] The first and second derivatives of $W(\cdot)$ are respectively: $W'(x) = -2F(x) + 1$ and $W''(x) = -2F'(x) = -2f(x)$. Therefore for symmetric densities around the median x^M the curvature of the welfare is the same for any two points that are the same distance from the median, so for any two such points the social welfare is the same.

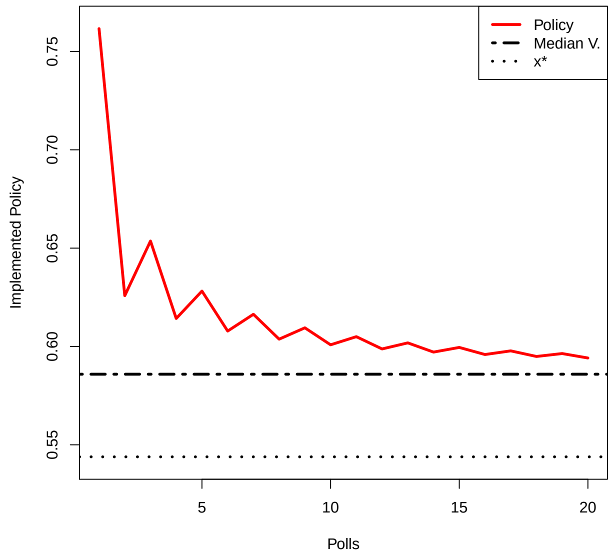

Figure 6: Beta distribution example, $\eta = \theta = 0.05$

Figure 6 we have $\eta = \theta = 0.05$. In this case we do not have convergence to the full information outcome: there will always be undecided voters and their mass cannot be lower than 67 per cent.

The implemented policy is decreasing on average, getting closer to the full information outcome, but it will never converge to it. The implemented policy converges to $x = 0.59$, while the complete information outcome is only $x^* = 0.5438$: the distribution is skewed to the left so there are relatively more undecided citizens located in ideologies close to R. The polls cannot reveal information to the more centrist undecided citizens so they do not vote: had they voted most of them would vote for L in order to counterbalance the great mass of R voters. The result is an implemented policy that is too much on the right. At the same time welfare is on average increasing with more polls, as the implemented policy is getting closer to the median citizen. Even though the polls cannot lead to complete information, on average more polls make the citizens more better-off. However we can see if there are not many polls conducted then the welfare has high variability from one poll to the other, and there are polls that are particularly bad in terms of welfare.

On the other hand, Figure 7 represents a Beta distribution with the same parameters but this time with $\eta = 0.1$ and $\theta = 0.05$. This specification corresponds to a case where party L has relatively more numerous partizans compared to the previous case, while the undecided are still skewed left. The mass of the undecided has now a minimum of around 20 per cent. Once again there is no convergence to the full information ($x^* = 0.5324$), but a slow convergence to 0.539. The welfare is on average decreasing as the number of polls increases. At the same time the implemented policy is getting closer to the full information outcome. As in the previous example, we see that a small number of polls in-

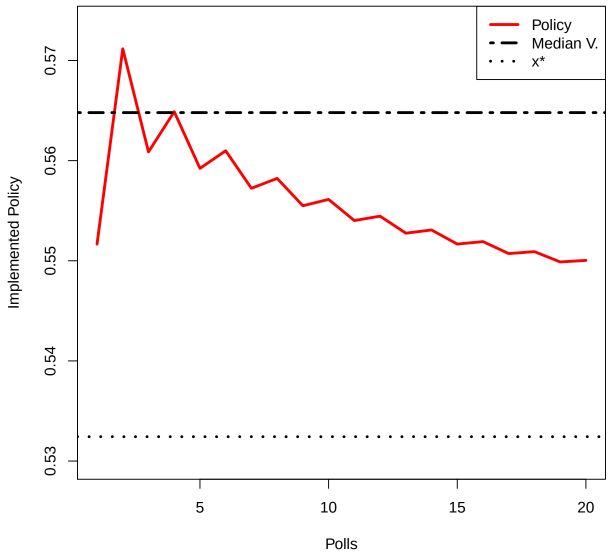

Figure 7: Beta distribution example, $\eta > \theta$

duces high variability to both the implemented policy and the citizen welfare. If the conditions for the convergence to the complete information hold, then we know that a sequence of polls can lead us to the complete information outcome. However, even in this case, both the implemented policy and the citizen welfare are not necessarily monotonic in the number of polls.

An interesting question is if it is beneficial for the society to have plenty of polls before the elections or whether there should be restrictions on their publication. The fact is that there is no way to know a priori if the polls will be welfare increasing or decreasing. Given a support, there is an infinite number of possible distributions, and in some of them the welfare will be on average increasing and in some others on average decreasing. What we can say however, is that with more polls, and as the implemented policy is converging, the variability of the welfare will decrease.

5 Conclusions

In this paper I examine a proportional representation voting model with polls and in which voters suffer from regret that is able to capture actual elections qualitative features, that to the best of my knowledge cannot be replicated by other models. First, the lack of monotonicity of the share of the leading party in the number of polls, second that the fact that a significant mass of voters declares to be undecided in polls when asked about what they are going to vote and that the mass of undecided is never increasing, and third that there is a positive correlation between having a centrist ideology and being undecided. The most important finding of the paper is that although each poll weakly decreases the mass of undecided voters, a sequence of polls may not always be able decrease this mass to zero and reveal the complete information outcome to the citizens. Polls have a non-monotonic effect on the implemented policy and social welfare. Finally, the average effect the effect of polls on welfare is ambiguous: more polls do not necessarily lead to higher social welfare.

A Position Uncertainty

Even though the citizens have preferences over the implemented policy, it can often be the case that their opinions can change from day to day, due to random political noise. The assumption that this section maintains is that, while a citizen's ideological position can change due to random shocks, this position will not stray to far away from his initial ideological position. I will model this by assuming that the optimal policy for each voter can move randomly around a small interval $[-\epsilon, \epsilon]$, with $0 < \epsilon < \eta, \theta$. This is the only difference with the previous model. That is, using the distribution of voter optimal policies we have previously defined as a reference, each voter's optimal policy can change from day to day, moving randomly in this small interval.

The timing of the new model is as follows. At time t the citizens calculate $[x_L^t, x_R^t]$, a poll takes place to which the voters respond truthfully, and then a shock takes place. A shock for citizen with initial position y is a random draw from the set $[y - \epsilon, y + \epsilon]$. For some extreme L partizans we will have that $y - \epsilon < -\eta$ and similarly for some extreme right partisans we have that $y + \epsilon > 1 + \theta$. This means that there can be draws that can make these partisans "fall over" the support D. If such draw takes place for a partizan then for simplicity we will assume that the shock will just move this citizen to the corresponding extremum of the support. For example, take an L partizan with initial ideological position $y = -\eta + \epsilon/4$. For this citizen the set that his shocks belong to is: $[-\eta - 3\epsilon/4, -\eta + 5\epsilon/4]$. Now assume that this citizens draw is equal to $-\eta - \epsilon/2$ then this would lead the citizen to outside the support D, so his draw will be corrected to be equal to $-\eta$, the minimum point he can move to. The shock is the new ideological position of the citizen. Some partizan voters, the most extreme ones, will stay partizans even if they receive a very big shock in the opposite direction. Afterwards we can have the elections, or we start over with a new poll. The shock is not necessarily common to all voters. Now at the beginning of the game, each voter y is aware of their initial optimal policy and the interval $[y - \epsilon, y + \epsilon]$ that their optimal policy can fall into.

These random shocks from day to day, obviously affect the distribution as they are moving masses of voters around. There are two interesting "perturbed" distributions: the one that results if *all* voters receive the most extreme negative shock meaning that all voters move the most they can towards L, which we call $F_{-\epsilon}(\cdot)$ and one that results if if *all* voters receive the most extreme positive shock (the one that moves all the most towards R): $F_\epsilon(\cdot)$. To see how this difference in the model affects the results, we will examine how a partizan voter would vote.

Take the left partizan voters, the ones whose initial optimal policies are distributed in $[-\eta, 0)$. We know already that $x_L^0 = 0$ so the implemented policy cannot be lower than 0. With no possible shock all of them would want to vote for L. However with the possibility of a preference shock, the partizan voters that are close to 0 know that there is the possibility of finding themselves in the other side of 0. The partizan voters that are absolutely sure of what to vote are the ones that are to the left of $y_L^0 = 0 - \epsilon$. Similarly the right partizan voters that are sure are the ones to the right of $y_R^0 = 1 + \epsilon$. We will call the y_L^k and y_R^k the highest possible cutoff for left voters after k polls and the lowest possible cutoff for right voters after k polls respectively and we will define them as follows: $y_L^k \equiv x_L^k - \epsilon$ and $y_R^k \equiv x_R^k + \epsilon$.

Then the mass of left voters that will be reported by a first poll will be: $F(-\epsilon) = F_\epsilon(0)$. The mass of the undecided will be: $F(1+\epsilon) - F(-\epsilon) = F_{-\epsilon}(1) - F_\epsilon(0)$. The minimum and maximum possible implemented policies are: $x_L^1 = 1 - F(y_R^0)$ and $x_L^1 = 1 - F(y_L^0)$. Now voters with initial optimal policies to the left of $y_L^1 \equiv x_L^1 - \epsilon$ will know that they will not regret their decision if they vote L, and so do the voters to the right of $y_R^1 \equiv x_R^1 + \epsilon$. If a second poll happens, then the we will have $x_L^2 = 1 - F(y_R^1)$ and $x_R^2 = 1 - F(y_L^1)$ and generally:

$$x_L^k = 1 - F(y_R^{k-1}) \tag{11}$$

$$x_R^k = 1 - F(y_L^{k-1}).$$

The proof of existence and uniqueness of the voting equilibrium follows the same lines as before and is therefore skipped. Rewriting the previous two equations and plugging the second one into the other we get:

$$x_L^k = 1 - F(1 - F(x_L^{k-2} - \epsilon) + \epsilon). \tag{12}$$

If similarly to the previous subsection we define the function:

$$h_\epsilon(x) = 1 - F(1 - F(x - \epsilon) + \epsilon), \tag{13}$$

we see that all the conditions for the existence of a fixed point still hold. Now however, there is no fixed point that corresponds to full information in the sense we have defined it previously. In other words, there does not exist a fixed point where all the voters have made up their minds.

Proposition 4. *The full information outcome cannot be achieved with uncertainty in preferences.*

Proof. Suppose not. Then there exists an s such that $y_L^s = y_R^s = y_L^{s+1} = y_R^{s+1} = y_L^* = y_R^*$. Then we have to have:

$$x_L^* - \epsilon = x_R^* + \epsilon$$

or,

$$x_L^* = x_R^* + 2\epsilon$$

which is a contradiction as x_L^* cannot be greater than x_R^*. □

We can also see that the results of Propositions 2 and 3 follow immediately using:

$$F'(1 - F(x - \epsilon) + \epsilon)F'(x - \epsilon) < 1 \tag{14}$$

The natural next question is to find the fixed point that corresponds to the "second best", where the mass of the undecided voters is as low it can get. An obvious candidate fixed point is a point where $x_L^* = x_R^* = x^*$, that is, the point that there is no uncertainty about the position of the implemented policy anymore. Then, we will have $y_L^* = x^* - \epsilon$ and $y_R^* = x^* + \epsilon$.

Proposition 5. *There is no fixed point of $h_\epsilon(\cdot)$ of the form $x_L^* = x_R^* = x^*$.*

Proof. Suppose that time s is the first time we observe $x_L^s = x_R^s$. Then the mass of undecided voters becomes $F(x_R^s + \epsilon) - F(x_L^s - \epsilon)$, and we have: $x_L^{s+1} = (F(x_L^s - \epsilon) + F(x_R^s + \epsilon) - F(x_L^s - \epsilon)) \times 0 + (1 - F(x_R^s + \epsilon)) \times 1 = 1 - F(x_R^s + \epsilon)$. Similarly $x_R^{s+1} = 1 - F(x_L^s - \epsilon)$, showing that $x_L^{s+1} \neq x_R^{s+1}$. □

Proposition 5 tells us that there cannot be a situation where there is no uncertainty about the implemented policy, which further implies that the ideological distance between the last voter to vote for L and the first voter to vote for R cannot be less than 2ϵ. The exact distance cannot be pinned down without first knowing the distribution function.

What we take from the preceding analysis is that the added uncertainty of preferences makes not only the full information outcome completely unattainable, but also puts a lower bound on the measure of undecided voters. As ϵ is getting smaller, more and more people are voting and we are getting closer and closer to full information. On the other hand, with larger ϵ, more voters stay away from the polls.

B Country Specific Regression Tables

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.063***	0.026***	0.024***	0.038***	0.030***	0.034***
	(0.012)	(0.010)	(0.007)	(0.010)	(0.011)	(0.008)
Center5	0.164***					
	(0.035)					
Center456		0.155***				
		(0.022)				
Center34567			0.114***			
			(0.019)			
Center56				0.182***		
				(0.027)		
Center4567					0.112***	
					(0.019)	
Center345678						0.080***
						(0.020)
NeverNational	-0.051	-0.032	-0.016	-0.044	-0.022	-0.009
	(0.041)	(0.034)	(0.042)	(0.034)	(0.041)	(0.062)
NeverLocal	0.356***	0.335***	0.353***	0.341***	0.349***	0.357***
	(0.085)	(0.083)	(0.102)	(0.081)	(0.086)	(0.125)
NoTrust	0.027	0.036**	0.013	0.035**	0.030*	0.011
	(0.018)	(0.015)	(0.016)	(0.016)	(0.016)	(0.021)
Observations	989	989	989	989	989	989
R^2	0.131	0.133	0.095	0.137	0.126	0.079
Adjusted R^2	0.126	0.129	0.091	0.132	0.121	0.074
Residual Std. Error (df = 984)	0.997	0.994	1.227	0.983	1.014	1.460
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 7: WLS Sweden

	(1)	(2)	(3)	(4)
Constant	0.206***	-1.467***	0.232***	-1.312***
	(0.027)	(0.197)	(0.031)	(0.220)
$Distance_1$	-0.128***	-1.116***		
	(0.026)	(0.257)		
$Distance_1^2$	0.020***	0.146**		
	(0.006)	(0.074)		
$Distance_2$			-0.109***	-0.756***
			(0.024)	(0.230)
$Distance_2^2$			0.013***	0.038
			(0.005)	(0.059)
NeverNational	-0.013	-0.106	-0.017	-0.122
	(0.046)	(0.407)	(0.045)	(0.408)
NeverLocal	0.326***	1.985***	0.327***	2.006***
	(0.089)	(0.475)	(0.087)	(0.475)
NoTrust	0.029	0.353	0.027	0.331
	(0.019)	(0.220)	(0.019)	(0.221)
Observations	989	989	989	989
Method	LS	Logit	LS	Logit
R^2	0.107		0.110	
Adjusted R^2	0.103		0.106	
Log Likelihood		-308.166		-306.817
Akaike Inf. Crit.		628.331		625.633

Note: *p<0.1; **p<0.05; ***p<0.01
(1) and (3) use heteroskedasticity-robust s.e.

Table 8: Distance Sweden

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.168***	0.115***	-0.030	0.156***	0.123***	-0.010
	(0.033)	(0.031)	(0.037)	(0.033)	(0.033)	(0.042)
Center5	0.219***					
	(0.036)					
Center456		0.233***				
		(0.030)				
Center34567			0.283***			
			(0.028)			
Center56				0.181***		
				(0.032)		
Center4567					0.168***	
					(0.030)	
Center345678						0.239***
						(0.035)
NeverNational	0.258**	0.278**	0.312***	0.261**	0.295***	0.331***
	(0.114)	(0.112)	(0.113)	(0.114)	(0.114)	(0.114)
NeverLocal	0.038	0.040	0.047	0.063	0.051	0.038
	(0.116)	(0.115)	(0.115)	(0.117)	(0.117)	(0.115)
NoTrust	0.110***	0.097***	0.144***	0.113***	0.108***	0.139***
	(0.037)	(0.034)	(0.038)	(0.037)	(0.036)	(0.039)
Observations	937	937	937	937	937	937
R^2	0.425	0.424	0.128	0.419	0.413	0.099
Adjusted R^2	0.422	0.421	0.124	0.416	0.410	0.095
123.212***						

Note: *p<0.1; **p<0.05; ***p<0.01, (3) and (6) use heteroskedasticity-robust s.e.

Table 9: LS Spain

	(1)	(2)	(3)	(4)
Constant	0.328***	-0.851***	0.382***	-0.649***
	(0.037)	(0.227)	(0.045)	(0.236)
$Distance_1$	-0.113***	-0.462***		
	(0.031)	(0.175)		
$Distance_1^2$	0.008	0.009		
	(0.007)	(0.054)		
$Distance_2$			-0.129***	-0.452***
			(0.030)	(0.174)
$Distance_2^2$			0.006	-0.030
			(0.007)	(0.050)
NeverNational	0.295***	1.381***	0.299***	1.557***
	(0.111)	(0.530)	(0.115)	(0.571)
NeverLocal	0.034	0.136	0.012	-0.085
	(0.113)	(0.547)	(0.116)	(0.586)
NoTrust	0.121***	0.654***	0.125***	0.682***
	(0.031)	(0.221)	(0.038)	(0.223)
Observations	937	937		937
Method	WLS	Logit	LS	Logit
R^2	0.425		0.149	
Adjusted R^2	0.421		0.144	
Log Likelihood		-555.126		-537.549
Akaike Inf. Crit.		1,122.251		1,087.098
Residual Std. Error	1.002 (df = 931)			

Note: *p<0.1; **p<0.05; ***p<0.01, (3) uses heteroskedasticity-robust s.e.

Table 10: Distance Spain

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.006	-0.011	-0.010	-0.010	-0.008	-0.023
	(0.008)	(0.009)	(0.011)	(0.008)	(0.011)	(0.015)
Center5	0.003					
	(0.013)					
Center456		0.010				
		(0.011)				
Center34567			0.006			
			(0.012)			
Center56				0.011		
				(0.011)		
Center4567					0.003	
					(0.012)	
Center345678						0.020
						(0.015)
NeverNational	0.129^{***}	0.129^{***}	0.129^{***}	0.128^{***}	0.129^{***}	0.128^{***}
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
NeverLocal	0.078^{***}	0.078^{***}	0.078^{***}	0.077^{***}	0.078^{***}	0.080^{***}
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
NoTrust	0.020^{**}	0.019^{*}	0.020^{*}	0.019^{*}	0.020^{**}	0.020^{*}
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Observations	1076	1076	1076	1076	1076	1076
R^2	0.120	0.120	0.120	0.120	0.120	0.121
Adjusted R^2	0.116	0.117	0.117	0.117	0.116	0.118

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$ all specifications use heteroskedasticity-robust s.e.

Table 11: LS Estonia

	(1)	(2)	(3)	(4)
Constant	-0.0004	-5.138^{***}	-0.0002	-5.122^{***}
	(0.010)	(0.550)	(0.012)	(0.565)
$Distance_1$	-0.007	-0.310		
	(0.013)	(0.442)		
$Distance_1^2$	0.001	0.055		
	(0.004)	(0.126)		
$Distance_2$			-0.007	-0.253
			(0.012)	(0.382)
$Distance_2^2$			0.001	0.045
			(0.003)	(0.100)
NeverNational	0.128^{***}	1.180^{***}	0.129^{***}	1.190^{***}
	(0.043)	(0.422)	(0.043)	(0.422)
NeverLocal	0.078^{***}	2.211^{***}	0.078^{***}	2.201^{***}
	(0.025)	(0.501)	(0.025)	(0.498)
NoTrust	0.020^{*}	0.801^{*}	0.020^{*}	0.802^{*}
	(0.010)	(0.466)	(0.010)	(0.466)
Observations		1,076	1,076	1,076
Method	LS	Logit	LS	Logit
R^2	0.120		0.120	
Adjusted R^2	0.116		0.119	
Log Likelihood		-130.552		-130.750
Akaike Inf. Crit.		273.105		273.499

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$ LS specifications use heteroskedasticity-robust s.e.

Table 12: Distance Estonia

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.159***	0.135***	0.091***	0.144***	0.096***	0.079**
	(0.028)	(0.029)	(0.029)	(0.028)	(0.028)	(0.032)
Center5	0.027					
	(0.029)					
Center456		0.073***				
		(0.026)				
Center34567			0.119***			
			(0.026)			
Center56				0.076***		
				(0.027)		
Center4567					0.115***	
					(0.025)	
Center345678						0.104***
						(0.029)
NoInterest	0.129***	0.130***	0.122***	0.123***	0.121***	0.126***
	(0.027)	(0.027)	(0.026)	(0.027)	(0.026)	(0.027)
NoTrust	0.062**	0.055*	0.057*	0.056*	0.068**	0.068**
	(0.031)	(0.031)	(0.030)	(0.031)	(0.030)	(0.030)
Observations	1,165	1,165	1,165	1,165	1,165	1,165
R^2	0.281	0.282	0.284	0.283	0.285	0.283
Adjusted R^2	0.278	0.280	0.282	0.280	0.283	0.281
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 13: LS Greece

	(1)	(2)	(3)	(4)
Constant	0.224***	-1.198***	0.200***	-1.307***
	(0.035)	(0.201)	(0.035)	(0.208)
$Distance_1$	-0.049*	-0.230		
	(0.029)	(0.157)		
$Distance_1^2$	0.003	0.004		
	(0.007)	(0.043)		
$Distance_2$			0.006	0.112
			(0.024)	(0.135)
$Distance_2^2$			-0.008*	-0.069**
			(0.005)	(0.032)
NoInterest	0.121***	0.622***	0.127***	0.656***
	(0.027)	(0.135)	(0.026)	(0.135)
NoTrust	0.063**	0.232	0.064**	0.206
	(0.030)	(0.187)	(0.029)	(0.188)
Observations	1,165	1,165	1,165	1,165
Method	LS	Logit	LS	Logit
R^2	0.285		0.283	
Adjusted R^2	0.282		0.280	
Log Likelihood		-659.747		-659.291
Akaike Inf. Crit.		1,329.494		1,328.583
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 14: Distance Greece

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