Reliability of Information Aggregation with Regional Biases: A Note*

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Abstract Is there a rationale for an electoral college system or do these voting systems always waste useful information? This paper studies this question in a setup in which voting is supposed to aggregate decentralized information about individual preferences for two candidates. Individual perceptions may be affected by regional information. When such regional information plays a major role, an electoral college system may be superior to simple majority voting.

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"The Founding Fathers were men of vision."[1]

1 Introduction

In the American presidential elections of the year 2000, the votes of one single state, Florida, were perceived to determine who would be the new president. In this context, the US electoral system, which is known as an "electoral college system" came under attack. It was blamed to "distort" voters' will, as the outcome that it yields may be different from that obtained by a simple majority vote.

In this paper we provide a simple theoretical argument why an electoral college system may in some situations have advantages compared to a simple popular vote. We build our analysis on a modified version of the classical information aggregation setup introduced by Condorcet (1785). A collective decision between two alternative candidates has to be taken. One of them, candidate A, is assumed to conduct policies that maximize the utilities of a majority of voters. The remaining voters are better off with candidate B. However, all voters are only imperfectly informed about the true identity of their ideal candidate. In our model individual perceptions about the two candidates may be affected by individual-specific and by regional information. We show that if regional information plays a major role in shaping individual perceptions, an electoral college system may be superior to simple majority voting.

The country is partitioned into a number of regions ("states") with an equal number of voters. In an electoral college voting system, each of these states gets one vote in the electoral college that determines by majority vote which candidate is elected. We assume that each electoral college member will vote for the candidate that the majority in the state she represents has voted for in a first stage. Popular vote instead leads to the election of the candidate who gets the majority of votes in the entire country.

Voters are not perfectly informed about the two candidates and their proposed policies. This is why they may make individual mistakes in identifying their own favorite candidate.[2] Individuals may get two types of signals: (i) individual specific signals and (ii) region specific signals.

[1] Al Gore's press secretary Chris Lehane - before the 2000 presidential elections. Quoted in: "Electoral College gives Gore hope. Despite trailing in polls" by Robert Russo, The Canadian Press.

[2] This assumption may be justified by a (time) cost that voters incur if they want to be perfectly informed about what kind of policy the candidates promise. Moreover, even if they know what the candidates are likely to do in each policy field, voters might find it difficult to calculate the effects on a

An individual specific signal is a voter's personal impression about the two candidates and their policy proposals. Region-specific signals instead affect all voters in a particular region. Such regional information could e.g. obtain, when a regional economic shock makes an incumbent candidate look less attractive to regional voters. This kind of information is likely to affect the perceptions and voting decisions of those who live in the region without necessarily affecting opinions of those living elsewhere. Regional information (or regional noise) can also obtain, if local media are biased towards one candidate. This information will raise the probability that those voters who would benefit from the candidate's policy get a positive perception of this candidate. At the same time the probability increases that voters who should actually vote for the candidate's opponent make a mistake. No one living outside the distribution area of the local media will be influenced - unless other media take up the news and make it a national issue.

The following example makes clear how regional shocks may have a different impact on the results in the two voting systems: Take a situation where candidate A is (objectively) better for 55 percent of the population. Individual information is imperfect and this is why, in absence of any region specific shock, candidate A only has a slight majority of votes in each state of - say - 51 percent[3]. Without any regional shocks, A would win the majority of votes in each state as well as the popular vote (see figure 1, column 1). In the electoral college, each representative votes for A, such that A wins the electoral college vote by one-hundred percent. Now think of an information shock that is rather extreme: If the shock occurs, all voters in a state either turn into B-voters or A-voters. Imagine such a shock occurs in state one and turns all its habitants into B-voters. The outcome of the electoral college vote does not change, as only one representative will now vote for B (figure 1, column 3). Candidate A still takes office as the new president. However, in the popular vote system, B may now be the winner: If there are less than 100 states, more than 1 percent of the total population lives in the state that has experienced the B-shock. Hence, less than 50 percent of the country's population will vote for A, and B wins the election under the popular vote system. Thus, in our example, the electoral college system is more robust to extreme regional information shocks than the popular vote system.

This paper generalizes this simple idea and derives conditions for the robustness of

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their utilities. Secondly, they may be influenced by some state-specific (regional) information shock that distorts their likelihood to identify the candidate that would maximize their utilities.

[3]The vote share of A is smaller than 55 percent because - with signals of identical quality - more A voters get a B signal than vice versa.

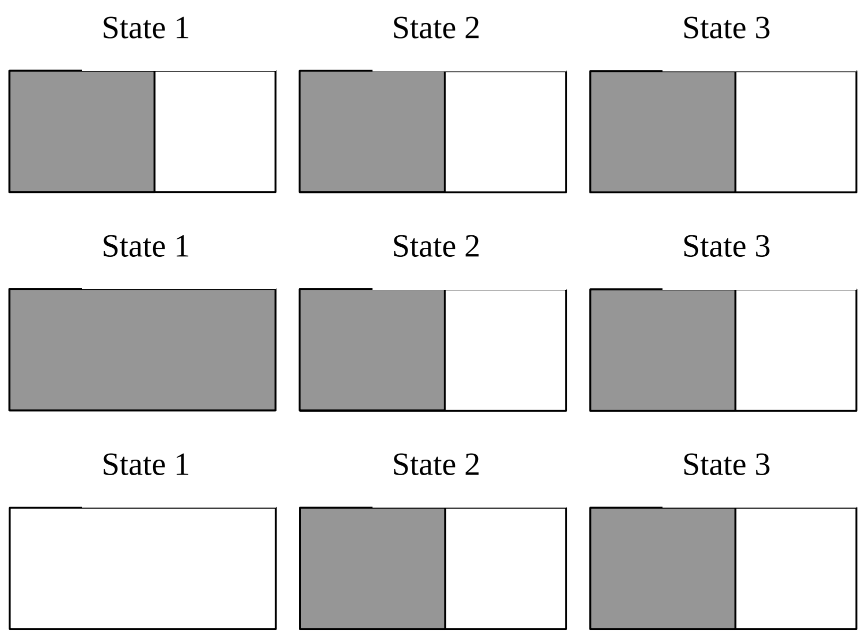


Figure 1: The first column refers to a situation with no regional biases. Grey denotes the majority of voters for candidate A. The second (third) column refers to the case where state 1 is biased in favor of candidate A (B).Under an electoral college system, A always wins, while, under popular vote A only wins in colums 1 and 2.

the basic result. We find that the probability that the welfare-maximizing candidate (the candidate which is better for the majority of voters) wins is higher in the electoral college system if regional information has a large impact on regional vote shares. If regional information shocks are small, the popular vote system is more likely to yield the optimal result.

1.1 Related Literature

Criticism of the electoral college system is widespread and primarily draws on the unequal distribution of voting power per voter. Lizzeri and Persico (2001) claim that the electoral college system is subject to inefficient provision of public goods. Earlier papers e.g. by Blair (1979) or Cebula and Murphy (1980) criticize the electoral college system as giving too little voting power to US minorities and discouraging voter participation. In a more recent piece of work, Cebula (2001) finds empirical evidence that the electoral college system discourages voter participation in states that have a history of leaning towards one party. On the other hand, he also finds evidence that the electoral college system fosters voters' will to participate in states where the two candidates are perceived to have the same chances of winning.

Theoretical work by Young (1988) shows that the Condorcet voting rule is not only suitable to find the better one of two alternatives, but can also be used to find the most likely ranking of alternatives, thereby reinforcing the statement that a simple majority vote is the best way to make a decision. The strength of the Condorcet Jury Theorem is further supported by Ladha (1992), who shows that for weakly correlated votes, the theorem still holds.

However, it is questionable whether these results can be found if regional ideological bias is taken into account: Strumpf and Phillippe (1999) show in an econometric study of presidential election voting outcomes from 1972 to 1992 that they can best be predicted by the partisan predisposition of the states. National and regional economic variables, which are supposedly useful information for determining which candidate is most suitable to govern the country, are less powerful in predicting election outcomes. If we interpret partisan predisposition as a regional information shock, we can get a new perspective on electoral systems, as is shown in our model.

The paper is also related to a growing literature on information aggregation in the political process.[4] While most of this literature assumes that individual information may

[4] An incomplete list is Austen Smith and Banks (1996), Feddersen and Pesendorfer (1996, 1997, 1999a,b) Coughlan (2000), Gerardi and Yariv (2002), Doraszelski, Gerardi and Squintani (2002),

be correlated, we are not aware of any paper that considers information shocks that only concern particular indentifiable subsets of the population. In contrast to most of this literature, the present paper does not focus on strategic voting. In order to make our point as easy as possible, we assume that each voter always votes in favor of the candidate who makes the best impression to them.[5]

2 The Model

2.1 Preferences and information

Consider a country, populated by a continuum of voters with mass 1, that is partitioned into m states of equal size. For simplicity we assume that m is an odd number. There are two candidates, A and B, running for president. We call r the share of voters who are better off with candidate A. The parameter r is drawn by nature at the beginning of the game from a probability distribution with density $f(r)$ which is symmetric around 1/2. For simplicity we assume that r assumes the same value in every state.

Throughout the paper and without imposing any restrictions on the generality of our results we consider a situation where a value $r > \frac{1}{2}$ has realized so that A would be the better candidate for the majority of the population. Each individual derives the same monetary payoff 1 if his/her preferred candidate is elected and 0 otherwise. Therefore efficiency requires that A is elected.

Individuals are not perfectly informed about which candidate is better for them, i.e. the elected candidate's quality only becomes observable after the election. However, each individual receives a signal about the relative qualification of both candidates. In a state where there is no specific regional information available, we assume that individuals get a correct signal with probability $q > 1/2$ when they compare both candidates. The share of voters who get signals which are in favor of candidate A is denoted by p and is given by

$$p = rq + (1 - r)(1 - q). \tag{1}$$

Note that p consists of the proportion of voters being in favor of A and identifying their preference correctly, rq, plus the share of voters who should actually vote for B but get the wrong signal, $(1 - r)(1 - q)$.

Mukhopadhaya (2003) and Persico (2004). See Gerling et al., 2003, for a recent survey.

[5]Given that we consider a continum of voters, sincere voting is not a problematic assumption in our setup.

2.2 Regional information

Additionally, in some states regional information emerges that affects the share of the population that votes for candidate A. Regional information can either be in favor of candidate A or candidate B. In a state with a regional signal in favor of candidate A the share of voters in favor of candidate A rises from p to $x > p$. We denote the probability that an A (B) voter gets a correct signal in a state with a candidate A shock with q_{AA}, (q_{AB}). The first index refers to the type of state-specific shock, the second one to the type of the voter. We assume that $q_{AA} > q > q_{AB}$. We have:

$$x = rq_{AA} + (1-r)(1-q_{AB}). \tag{2}$$

Similarly, in a state with a regional signal in favor of candidate B the share of voters in favor of candidate A falls from p to y. We have:

$$y = rq_{AB} + (1-r)(1-q_{BB}). \tag{3}$$

We assume that regional shocks are symmetric in the sense that $q_{AA} = q_{BB}$, and $q_{AB} = q_{BA}$. If all signals in states with regional information remain informative in the sense that

$$q_{XY} > 1/2 \ (X, Y \in \{A, B\}), \tag{4}$$

we get that

$$\frac{r}{2} < y < r < x < \frac{1+r}{2}. \tag{5}$$

If - due to a regional shock - some signals may become uninformative the following weaker parameter restrictions hold:

$$0 < y < r < x < 1. \tag{6}$$

Throughout the paper we consider the (non-trivial) case in which a regional information shock in favor of candidate B leads to a majority in favor of candidate B in this state, i.e. we assume that $y < 1/2$.

The number of states with regional signals in favor of A (B) is denoted by a (b). The shocks are drawn from symmetric joint probability distribution with density

$$\begin{aligned} \phi(a,b) &> 0 \text{ if } a+b \leq m, \\ \phi(a,b) &= 0 \text{ if } a+b > m. \end{aligned} \tag{7}$$

2.3 Timing

The timing in this game is as follows: in the first stage, nature (i) draws the parameter r from a distribution with density $f(r)$ and (ii) chooses each voter's preferred candidate. In the second stage, nature chooses a and b according to the density $\phi(a, b)$. Moreover, each individual voter gets an impression about who maximizes his/her utility. In some states this impression is subject to regional shocks. Finally, the election takes place, either A or B get elected, and voters' payoffs are realized.

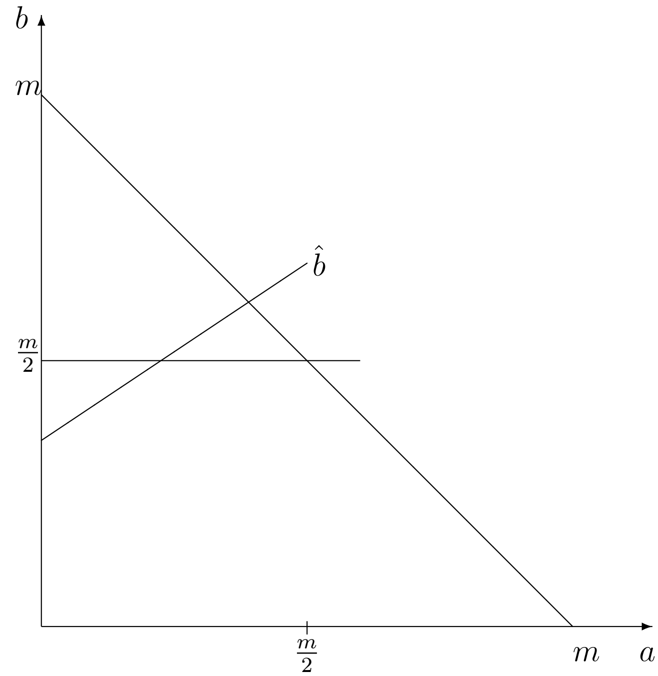
2.4 Sincere voting

By assumption, the electorate in each region is large. Hence, no voter is ever pivotal and sincere voting constitutes a Bayesian equilibrium of the voting game. Generally, sincere voting need not be an equilibrium of games with finitely many voters when the majority rule is not the appropriate one (c.f. Austen-Smith, and Banks (1996), Feddersen and Pesendorfer (2000) or, for a survey on this issue Gerling, Grüner, Schulte, and Kiel, 2004). However, in the present model sincere voting also constitutes a trembling hand perfect equilibrium of any finite version (with an odd number of voters per region) of the present model. The reason is that with a symmetric density $f(r)$ the initial probability that candidate A or B is the majority's preferred candidate is 1/2. Moreover, the conditional probability distribution of individual signals is fully symmetric. Therefore, an agent learns nothing about his own true preference from being pivotal in a situation in which all other agents decide to vote truthfully. This result can further be strenghenend. Actually an agent can not deduce anything from being pivotal in any situation in which other players' strategies are symmetric in the sense that the probability that a player with an A signal votes for candidate A is the same as the probability that a player with an B signal votes for candidate B. Therefore, sincere voting constitutes the only symmetric and trembling hand perfect equilibrium of any discrete version of our game. Therefore, we consider sincere voting to be the most obvious way to play the present game and we shall concentrate on this equilibrium throughout the paper.

3 Results

In the electoral college system, candidate A wins if and only if the number of B-biased states is smaller than half the total number of states, i.e. if and only if $b < m/2$. In the popular vote system, candidate A wins as long as the number of people voting for A is

Figure 2: Combinations of a and b



larger than half the population:

$$by + ax + (m - a - b)p > \frac{m}{2}. \tag{8}$$

Here by is the number of individuals voting for A in B-biased states, ax is the number of A-voters in A-biased states, and finally, $(m - a - b)p$ are those who vote for A in the states that are not biased.

The maximum number of B-biased states that can be tolerated by a popular vote system such that A still wins can be obtained by solving equation (8) for b:

$$\hat{b} = m\frac{p - \frac{1}{2}}{p - y} + a\frac{x - p}{p - y}. \tag{9}$$

These findings are illustrated in figure 2: The combinations of a and b that make candidate A win the election in the electoral college are those below the $b = \frac{m}{2}$-line. In the popular vote system, the winning combinations for candidate A lie below the line labeled $\hat{b}$. Note that the two systems always yield a victory for A if the number of A-biased states is greater than $\frac{m}{2}$. We can now compare both systems.

Proposition 1 *If $y \leq 1 - x$ and $\phi(a, b)$ has full support, the probability that candidate A wins is higher in the electoral college system than in the popular vote system.*

PROOF We will show that those combinations of a and b that yield a victory for A in the popular vote system are a strict subset of those that make A win in the electoral college. Then, the probability that A wins must also be higher in the electoral college system. It suffices to show that, for any value that a can take, the number of B-biased states tolerated by the system is greater in the electoral college system. The proof is by contradiction: On the left hand side of the first line of (10), we have the maximum number of B-biased states that yield a victory for A in the popular vote system. On the right hand side, we have $m/2$, which is the maximum number of B-biased states that is tolerated by the electoral college system such that A still wins.

$$\begin{aligned} \hat{b} &> \frac{m}{2} \\ \Leftrightarrow & \frac{m\left(p-\frac{1}{2}\right)+a\left(x-p\right)}{p-y} > \frac{m}{2} \\ \Leftrightarrow & a\left(x-p\right) > \frac{m}{2}\left(1-p-y\right) \\ \Leftrightarrow & a > \frac{m}{2}\frac{1-p-y}{x-p}. \end{aligned} \tag{10}$$

With $y = 1 - x$ we get:

$$a > \frac{m}{2}\frac{1-p-1+x}{x-p} = \frac{m}{2}. \tag{11}$$

Only if $a > m/2$, the popular vote system could tolerate a higher number of B-biased states than the electoral college system. However, if this condition is fulfilled, A would win in both systems anyway. We can easily see that if $y < 1 - x$, condition (11) becomes even stronger: The nominator of the fraction on the right hand side gets bigger, such that the whole fraction is greater than 1, which means that a would have to be even bigger than $m/2$ in order to fulfill the condition. Q.E.D.

The finding of proposition 1 is illustrated in figure 3: Area E containing the combinations of a and b that yield a victory for A in the popular vote system lies within the area below $b = \frac{m}{2}$, that contains the combinations of a and b that let A win in the electoral college system.

Next we have:

Proposition 2 *If $y \geq 1 - p$ and $\phi(a, b)$ has full support, the probability that candidate A wins is higher in the popular vote system than in the electoral college system.*

PROOF We have to show that the combinations of a and b yielding a victory for A in the electoral college system is a subset of those that do the same in the Popular Vote

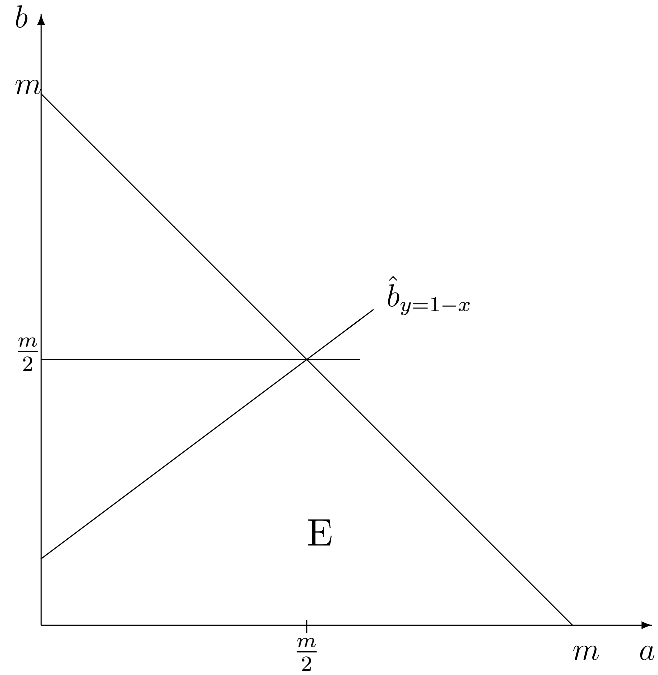


Figure 3: $y = 1 - x$: Electoral College is superior

system. If we substitute $y \geq 1 - p$ into (10), which is given by

$$a > \frac{m}{2}\frac{1-p-y}{x-p},$$

we get $a > 0$. That means that $\hat{b}$ is greater than $m/2$ for any value a can take. Q.E.D.

This finding is illustrated in figure 4: Area E containing the combinations of a and b that yield a victory for A in the electoral college system lies within the corresponding area for the popular vote, which consists of areas E and F. If every combination is assigned a positive probability, we can infer that the probability that A wins is higher in the popular vote system.

If region-specific information shocks are large, the electoral college system yields a higher expected satisfaction with electoral results. If shocks are small, popular vote is more likely to yield the desired outcome. To summarize we have:

Proposition 3 *For each given combination of m, p and x and each density function $\phi(a, b)$, there exists an interval (y^*, y^{**}) with $(1 - x) \leq y^* \leq y^{**} \leq (1 - p)$ such that*

(i) for values of y above y^{**}, popular vote yields a higher probability that candidate A wins than electoral college.

(ii) for values of y below y^*, electoral college yields a higher probability that A wins than popular vote.

(iii) In the case that $y^* < y^{**}$, the two systems are equivalent in the interval (y^*, y^{**}).

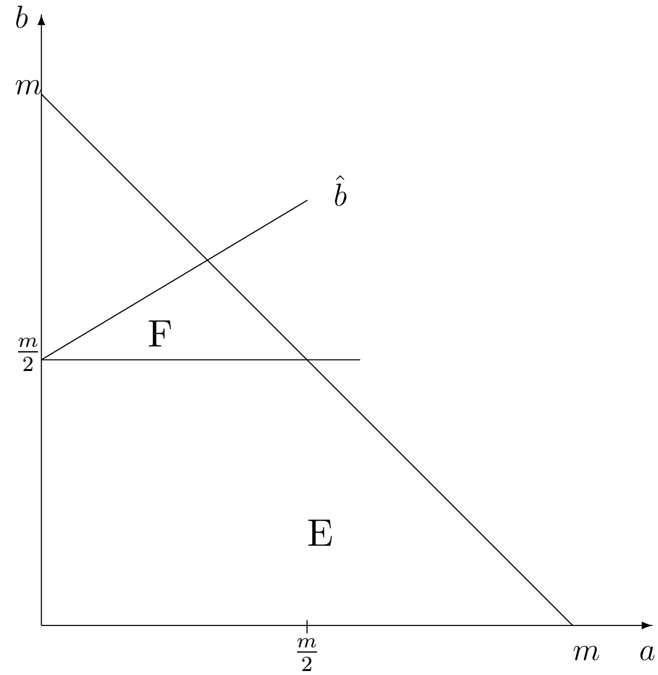


Figure 4: $y = 1 - p$: Popular Vote is superior

PROOF The smaller the number of combinations of a and b providing a victory for candidate A is, the smaller is the probability that A wins in a given system. Due to the discrete nature of these A-combinations, their number is weakly monotonically increasing in y. This means that A's probability to win is increasing stepwise in y. We have already shown that the number of A-combinations is larger in the Popular Vote system than in the electoral college if $y \geq 1 - p$. And we have shown that this number is smaller in the Popular Vote system if $y \leq 1 - x$. The proposition follows immediately. Q.E.D.

4 The number of electoral college votes

A fundamental complaint about the electoral college in the United States is that different states received different numbers of electoral college votes. Should states of different size also have a different number of electoral college votes? The present model can be extended to address this question. Interestingly, the answer may be negative. In this section we study an example in which a system with a proportional representation of states in the electoral college is less likely to elect the majority's preferred candidate than a system of uniform representation (in which all states have the same number of electoral college votes).

Consider a country with a large population and five states. Assume that 40 percent of the population live in state one, while the remaining 60 percent live in four states of equal size (states 2 - 5). Under a system of proportional representation, state one would be granted 40 percent of the electoral college votes, the rest of votes is evenly distributed among the remaining four states. Information aggregation may be inefficient when regional information plays a major role. Suppose again that candidate A is preferred by a majority of voters. A regional shock in favor of candidate B in two states distorts the outcome of an electoral college vote under proportional representation as soon as state one is of these two states. When the regional information shock affects all votes in a state, the total vote in the electoral college in favor of candidate B would rise to 65 percent. This can not happen under uniform representation where only 30 percent of the electoral college vote would be affected by two regional shocks. Obviously, probability distributions $\phi(a,b)$ exist, such that the system is completely robust to regional shocks under uniform representation while it is not under proportional representation. This is the case when $\phi(a,b) = 0$ for all $a - b > 2$. In this case uniform representation is strictly superior to proportional representation when $\phi(a,b) > 0$ for all $a - b < 2$.[6]

Which of the three systems, electoral college with or without representation, or the popular vote is best depends on the relative importance of regional information and the variation of the true preferences across states. Popular votes performs best in absence of any regional shocks. A major advantage of proportional representation with respect to a system of uniform representation is that the former system performs well when, without regional information biases, the true proportion of A-voters strongly differs across states. In this case a system of regional representation is equivalent to a system with popular vote. One should expect that - with a small probability of regional biases in medium sized regions - proportional representation outperforms popular vote and becomes the most reliable voting system.

5 Concluding Remarks

We have shown that an electoral college system is more robust towards large regional information shocks than a popular vote system. The candidate who generates better results for a majority of voters is more likely to win despite significant state-specific

[6]The superiority of an electoral college with uniform representation is no general result as one can easily verify. Consider e.g. the (unlikely) case in which regional information in favor of candidate B occurs in at least 4 states. The system with proportinal representation is unaffected if state 1 happens to be the only unbiased state while the system with uniform representation would fail in presence of any such shock.

noise if he is not elected directly. Consequently, a country should consider to turn to an electoral college system with proportional state representation if states are heavily exposed to idiosyncratic information shocks.

We have derived this results from a simple model of cross-regional information aggregation. In particular, we have assumed that regional information may only occur in form of two signals which either increase or reduce the number of voters in favor of a candidate by a given amount. It would be useful to study a more general setting in which regional information may be more diverse and to further study cases in which states differ in size and initial preferences. An empirical evaluation of the relative importance of regional information in election is another important task. Finally, one may attempt to find the optimal voting mechanism for different probability distributions of r, i.e. the electoral system that maximizes the ex-ante probability to elect the welfare-maximizing candidate.

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