

1 Some issues on voting systems

The first proposal is a new election system called *dynamic constituency*. One of the problems in an election system is the configuration of electoral districts. The combination of districts with voting systems (majority vs. proportional) generates problems, in the sense that representation fairness is not assured. Let us first discuss majority and proportional systems used over a district configuration.

Majority voting selects the most voted candidate per district, and the rest of the votes are, in some sense, lost. The advantage of majority voting is that it establishes a direct relation between the constituents (all electors in the district) and the elected representative. Indeed, the elected person (theoretically) represents all persons in the district, and is easier (than in proportional systems) for the citizens to direct questions, recommendations, objections, and recriminations to the elected representative. France and U.S. use majority voting for the Assembly and the Chamber of Representatives. The U.S. law intends to improve accountability of the representatives by having an election every two years; this legal provision designs a mechanism that intends to convey in a fast fashion changes in the public opinion to the representative body.

Summarizing, the main problem of majority voting is that the preferences of the public (expressed as votes) can be very different (proportionally speaking) to the preferences of the elected body. Defenders of majority voting argue that this shortcoming is compensated by its advantages: geographical representation, a more stable government supported by clear majorities, and the direct link between representative and constituents. However, a more stable government depends also on the party configuration, so majority voting does not assure this property (and proportional systems can also be argued as a good tool for government stability). Finally, the configuration of districts is critical and there is no insurance that by means social engineering an government customizes to its party needs a district configuration. The majority voting system can be improved using more fair voting systems, like approval voting, but only inside a district: the overall effect will continue to show a gap between the landscape of citizen preferences and group distribution in the elected body.

Proportional voting is a multi-winner election systems which try to ensure that the proportional support gained by different groups is accurately reflected in the election result. Some countries, like Israel, are close to a pure proportional voting systems, while other countries that use “corrected” proportional systems where majority groups receive an excess representation weight while minority groups are abated. Districts are larger and allow multiple winners while majority voting has small districts and single winner. However, geographical distribution of power, implemented as districts with large or small population may be unfair: an elected representative needs a larger number of votes than one in a low population district. Therefore, the configuration of districts has also undesirable effects in proportional systems — e.g both Spain and Israel use the

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d'Hondt method¹ for allocating seats but the district configuration in Spain has the effect of biasing proportionality in favor of large parties while Israel achieves a quite unbiased proportionality by having a single, global district. A way to compensate this effect is using mixed systems —like the *double vote* system under discussion for the future Catalonia's Electoral Law (inspired by the Germany law) where each citizen has two votes: one for a single-winner majority vote district election and another for a party-list proportional vote. Another problem with proportional voting (together with party lists) is that the direct link between the constituents and the elected person is blurred or altogether lost. In fact, the notion of constituency is difficult or impossible to effectively maintain in the proportional systems. Again, to improve the system, some countries implement mixed systems where some representatives are elected proportionally using party lists and other representatives are elected by majority vote.

Both majority and proportional voting systems can be improved using more fair voting systems, like approval voting, or designing mixed systems. However, I'd argue that all the negative effects (and the compensating mechanisms that can be introduced) are caused by the existence of electoral districts, and that they can be abolished while maintaining the notion of constituency and a direct link between citizens and the person they have elected. Moreover, geographical representation is faithfully reflected, in the sense that the preferences of the citizens depending on the interests and problems present in specific places and not others are proportionally represented. Finally, the property of having stable governments also depends, as already discussed, more on the configuration of parties than on the election system.

2 Dynamic constituency

The existence of digital infrastructures for e-voting in the near future allows us to rethink the possible methods for voting that avoid some of the undesirable properties of our current methods. In particular, we have argued that the establishment of districts and the particular configuration of districts leads to some undesirable properties. We can think of a method that abolishes districts while maintaining the notion of constituency and is proportional systems while maintaining the direct link between citizen and representative as in the majority system: dynamic constituency.

While district-based majority voting defines the constituency of a representative as all the residents of an electoral district, and proportional systems blur this notion, dynamic constituency considers that the citizens that voted a representative form its constituency. The digital infrastructure supports the ballot computing that previously was made at hand on electoral districts, so now is possible to have just one district for the whole territory. Moreover, the digital

¹ An alternative method is the Sainte-Lagu method of the highest average that is less biased in favor of large parties. New Zealand, Norway, Sweden, Bosnia and Herzegovina, Latvia and Bremen use the Sainte-Lagu method while Israel, Austria, Poland and Spain use the d'Hondt method.

infrastructure may be able to keep an anonymous relation between elector and representative that can support interchange of information between the (distributed) constituents and their representative.

Moreover, dynamic constituency simplifies the election system constrained by the need to allocate seats to districts. In dynamic constituency, any citizen can simply vote for the representative of its choosing, and if this candidate gets enough votes he will be elected. Moreover, the digital infrastructure can give the citizen an identification key that maintains his anonymity but allows her later to log in, identify herself, and direct question, comments, complaints, etc. to her representative in a seamless way. Thus, the representative can have an even more direct and transparent link to her constituency, and the citizens can feel more close the candidate they really voted instead of the winner of their district that they did not vote.

The voting system is also simplified: the most voted candidates are elected. Let us consider an example for illustrating this proposal: Catalonia has a Parliament with 135 seats elected by (around) 5,300,000 electors. This means that a MP is elected with 39,260 votes — and since usually only 70% of electors do vote, with 3,710,000 votes a MP needs about 27,600 votes to be elected. Once a candidate has 27,600 votes is virtually elected.

Another interesting feature that can be implemented is that of approval voting. In approval voting the citizen can vote to more than one candidate: she votes all candidates that she approves of. Since the digital infrastructure supports real-time computing of ballots it would be possible for the citizen to see the different candidates ballot at every moment. This goes against our current practice but this is just because it was not feasible before. We can argue that transparent real-time balloting may indeed attract to citizens who often abstain to try to help her preferred candidates².

Real-time balloting in dynamic constituency allows a citizen that approves of several candidates to vote for one of them, disregarding those others that already have enough votes to be elected. For instance, in the Catalonia parliament example, if a citizen than approves candidates A and B can vote for B once she sees that A already has 28,000 votes. However, if she really wants to be a part of A's constituency she can also vote A (although this implies that she really prefers A, for whatever reasons, to B). Although this is not approval voting it achieves the effects for which approval voting was designed: selecting a candidate in a manner that insures the minority preferences are taken into account.

Notice also that geographical representativeness is also preserved, as far as citizens prefer to vote for local candidates and the political organizations choose to locally promote specific candidates. However, minority groups may choose to globally promote a few specific candidates. For instance, considering the King-

² Some countries have single-day elections, some have a couple of days to cast a vote. Notice that the digital infrastructure also changes that: since balloting is automated elections can be held during several days or a week where real-time feedback shows the tendencies of eager voters and attract lazy voters with the expectation of their capability to modify them

dom of Spain as a multinational state, some people would think that minority nationals such as Basques, Catalans, and Galicians would be against using dynamic constituency for electing the Spanish parliament. This is not so, since as long as Catalan electors, for instance, vote for Catalan candidates they would be elected. Nonetheless, the dynamic constituency approach with real-time ballot feedback can be adapted to a federal territorial organization. For instance, the U.S.A. can first allocate a number of seats to each state for the Chamber of Representatives and then use the dynamic constituency approach within each state candidate election; the states members of the European Union may also favor this federal distribution of seats. Although the seat distribution among states introduces a bias the dynamic constituency approach still eliminates electoral districts and helps a better representation of minority vote.

A more radical simplification can be achieved if we eliminate the idea of having a fixed number of seats in a parliament once districts are abolished. If we think about the idea of a fixed number of seats we see that it is strongly linked to the existence and number of districts. In fact, some of the perverse effects detected by the proponents of different election and voting systems comes from the fact that there is a number n of seats to be allocated. Once we abolish districts and apply dynamic constituency we can just declare that any candidate with m votes will have a seat. For instance, Catalonia Election law could establish that every candidate with 30,000 votes wins a seat as MP. The number of seats may vary on a certain range depending on the number of electors that abstain to vote. There is a few practical problems to adapt a Parliament infrastructure to this small variability, but the advantages of proportionality and transparency make up for these drawbacks. The transparency of European Union MP elections (that has 626 MP for 379,790,700 citizens, soon 454,018,500 citizens) could be improved with this kind of method (e.g. one MP seat for every 500,000 electors); this would allow some groups to vote for local concerns and others to organize global (albeit minority) concerns in a proportional and transparent way.

3 Accountability for representatives

Once the digital infrastructure supports a direct and anonymous link between constituents and representative, this technological platform can be used for several purposes: to improve information flow between constituents and representative, Internet-based forums and discussion of the representative actions and the constituents opinions, etc.

In addition to supporting information tasks, the digital infrastructure can support different accountability mechanisms that can legally defined but that are feasible only because the existence of this digital infrastructure. In particular, it is possible to implement an impeachment mechanism by which a constituent may revoke her vote for an elected representative. Specific laws may define the number of revoked votes that imply a removal from office of the representative, as well as some grace period (e.g. a representative can not be removed during the first six months of her term). The technology that supports an anonymous

direct link between constituents and representative when the citizens vote is the one that insures the viability of the citizen impeachment of representative. An improved information flow together with the impeachment mechanism achieves a good accountability relationship between representative and constituents.

The purpose of an impeachment mechanism is the same as that of the U.S. Chamber of Representatives election every two years: assure a faster feedback of the constituents evaluation of the representative actions. Clearly, impeachment is cheaper in time, effort and funding than halving the election term from 4 years to 2. In addition, impeachment in dynamic constituencies allows the citizen that revokes a vote to a representative to one of the candidates that did not reach the vote threshold to become a MP. This allows a fast change in the Parliament when there is a sweep in public opinion, both by representatives changing their actions or being removed from office. Let's consider the two scenarios we explained before: dynamic constituency with and without a fixed number of parliament seats. When this number is fixed, at the moment an impeached representative is removed from office the non-elected candidate with the higher number of votes becomes an MP. When the number of parliamentary seats is not fixed the non-elected candidate that collects dissatisfied votes becomes an MP when these votes achieve the legal threshold.

4 Discussion

Digital technology can be used for supporting our current methods for elections, voting, and representation; but this technological effort only has an effect on improving certain efficiency parameters, e.g. faster computation, less error-prone techniques. Certainly this is quite important, e.g. since the technological infrastructure facilitates the realization of referendums, this can increase the use of referendums and thus change the political process. Moreover, we have not discussed the technical issues to be solved to have a digital infrastructure as the one envisioned here, nor the legal and public awareness issues that should be addressed and resolved.

The claim of this paper is once a technological infrastructure for e-government in general, and e-voting in particular, is in place we can easily exploit that platform to change and improve the methods and systems used in democratic political systems. This infrastructure envisions not only quantitative changes but more importantly qualitative changes in the form of the political process. We have shown several concepts that can be employed for democratic representation: dynamic constituencies, real-time vote feedback, and citizenship impeachment. This new concepts imply rethinking established concepts —like districts, opaque vote counting, and fixed number of seats. But once the technological infrastructure is feasible, public discussion of democratic representation and accountability will enter a wider realm of possibilities and hopefully improve the quality of democracy.

5 References

- (1) Steven J. Brams and Dudley R. Herschbach (2001), *The Science of Elections*, *Science* May 25, 2001: 1449.

Appendices

A Definitions

Most definitions are taken from the Wikipedia (<http://en.wikipedia.org>).

Civics is the science of comparative government and means of administering public trusts - the theory of governance as applied to state institutions. It is usually considered a branch of applied ethics and is certainly part of politics.

E-government is generally agreed to derive from 'electronic government' which introduces the notion and practicalities of 'electronic technology' into the various dimensions and ramifications of government, specially the delivery of public services, where there is an 'online' or Internet based aspect to the delivery of the services, the conduct of government business where the activities of those involved in the process of government itself (such as legislators and the legislative process) where some electronic or online aspect is under consideration, and voting where some online aspect is under consideration.

Electoral system An electoral system is the use of particular voting systems to place some group of people in charge of administration of a legal system under pre-existing legal codes

Voting system Voting systems are methods (algorithms) for groups of people to select one or more options from many, taking into account the individual preferences of the group members

B Hyperlinks

- Approval voting: http://en.wikipedia.org/wiki/Approval_voting
- Borda count: http://en.wikipedia.org/wiki/Borda_count
- Condorcet method: http://en.wikipedia.org/wiki/Condorcet_method
- Deliberative democracy: http://en.wikipedia.org/wiki/Deliberative_democracy
- Direct democracy: http://en.wikipedia.org/wiki/Direct_democracy
- Participatory democracy: http://en.wikipedia.org/wiki/Participatory_democracy
- Ramon Llull: http://en.wikipedia.org/wiki/Ramon_Llull
- Sainte-Lagu method: http://en.wikipedia.org/wiki/Highest_method
- Voting systems <http://en.wikipedia.org/wiki/Voting>

C Criteria in evaluating voting systems

Various criteria can be used in evaluating voting systems. However, it is impossible for one voting system to pass all criteria in common use. Arrow's impossibility theorem (http://en.wikipedia.org/wiki/Arrow%27s_impossibility_theorem) demonstrates that the following criteria are mutually contradictory:

- The voting system should always give a result
- If a voter improves the ranking of a particular option, that option should not be disadvantaged (monotonicity criterion)
- Removing a candidate should not change the winner of an election unless that candidate is the winner (independence of irrelevant alternatives)
- Every possible outcome should be achievable
- Non-dictatorship (i.e. more than one person's vote matters)

However, not all hope is lost. Weakening one of Arrow's conditions the Condorcet method meets all the criteria. The Condorcet winner of an election is the candidate who, when compared in turn with each of the other candidates, is preferred over the other candidate. A Condorcet winner will not always exist, however. Any voting system which chooses the Condorcet winner when it exists is known as a Condorcet method, after its deviser, the 18th century mathematician and philosopher Marquis de Condorcet, although it appears that the method was already thought up by Ramon Llull in the 13th century (see <http://www-gap.dcs.st-and.ac.uk/~history/HistTopics/Voting.html>).

Since the most complicated part of the Condorcet method consists of resolving cyclic ambiguities when the Smith³ set contains multiple candidates the use of Information Technology in election systems infrastructure eliminates the practical problems of Condorcet methods.

D Approval voting

Approval voting is a voting system used for single-winner elections, in which each voter can vote for as many or as few candidates as the voter chooses. Approval voting is a limited form of range voting, where the range that voters are allowed to express is extremely constrained: accept or not.

Approval voting passes a form of the monotonicity criterion, in that voting for a candidate never lowers their chance of winning. Indeed, there is never a reason for a voter to tactically vote for a Candidate X without voting for all candidates she prefers to Candidate X. A good strategy is to vote for every candidate the voter prefers to the leading candidate, and to also vote for the leading candidate if she is preferred to the current second-place candidate. When all voters follow this strategy, the Condorcet winner is almost certain to win.

A study by Approval advocates Steven Brams and Dudley R. Herschbach published in Science in 2000 argued that approval voting was "fairer" than preference voting on a number of criteria. They claimed that a close analysis shows that the hesitation to

³ The Smith set is the smallest set of candidates such that each candidate in the set beats (in the pairwise sense) each candidate not in the set. The Smith set is a reasonable and slightly less stringent definition of an "irrelevant" candidate of Arrow's framework.

support a 'compromise candidate' to the same degree as one supports one's first choice (as approval voting requires) actually outweighs the extra votes that such second choices get. Accordingly, preference voting is more biased towards compromise candidates than approval voting - a non-obvious and surprising result. Citizens for Approval Voting was organized in December 2002 to promote the use of approval voting in all public single-winner elections.

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D.1 Proportional approval voting

Proportional approval voting (PAV) is a theoretical voting system for multiple-winner elections, in which each voter can vote for as many or as few candidates as the voter chooses. It was developed by Forest Simmons in 2001.

Each potential result of the election will satisfy some voters more than others. The satisfaction for individual voters of a potential result depends on how many of the successful candidates they voted for. In this particular system, if an individual voted for n successful candidates (and an irrelevant number of unsuccessful ones) then their satisfaction is taken to be $(1 + 1/2 + 1/3 + \dots + 1/n)$. Adding up the satisfaction of all the voters with the potential result gives the total satisfaction with that result. The potential result with the highest satisfaction is the decision.

If there was only one winner then proportional approval voting would become simple approval voting. Alternatively, if each voter only voted for all the candidates of a single party then the results would essentially be the same as the D'Hondt method of party-list proportional representation.

Proportional approval voting is a computationally complex method of vote counting. If there were c candidates and w winners, then there would be $c!/(w! * (c-w)!)$ potential results to compare with each vote. If there were 20 candidates for 5 seats then there would be more than 15,000 potential results. Such elections could only reasonably be counted by computer.