Exhaustion

Senate Ballot Paper Study 2016

AEC
Australian Electoral Commission

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Summary

- There were 1,040,865 exhausted votes in the 2016 Senate elections. These exhausted votes were associated with 6,835,451 exhausted ballot papers.
- Nationally, 7.5 per cent of formal Senate votes exhausted.
  - The highest exhaustion rates were New South Wales (9.2 per cent), Victoria (8.58 per cent) and Queensland (7.67 per cent).
  - The lowest exhaustion rates were the Northern Territory (where no votes exhausted), the Australian Capital Territory (0.04 per cent) and South Australia (2.0 per cent).
- Exhausted ballot papers and votes are a normal part of preferential voting, except in strict Full Preferential Voting systems.[1]
- An exhausted vote is not an informal or wasted vote, and can contribute to one or more candidates being elected before exhausting
  - More than eight in ten exhausted ballots (86.5 per cent) helped elect at least one candidate at the 2016 Senate elections. More than half (56.7 per cent) of exhausted ballot papers helped elect four or more candidates.
- Levels of exhaustion at the 2016 Senate elections are not strictly comparable to levels of exhaustion under the previous Senate election system.
- Changes in the composition of the Senate subsequent to the 2016 federal election have not been incorporated into analyses but would not affect the overall findings.

Exhaustion in Senate elections

In the context of the Australian federal Senate voting system, 'exhaustion' occurs when a ballot paper has no valid preferences left for any of the continuing (i.e. not elected and not excluded) candidates.

From 1984 to 2014 Senate elections had very low levels of exhaustion, as the Full Preferential Voting (FPV) system in use precluded large scale exhaustion. Substantial reforms to the Senate voting system were introduced in 2016; these included the introduction of Partial Preferential Voting (PPV)[2] which greatly increased the rate of exhaustion.[3]

Exhausted ballot papers and exhausted votes are related – but distinct – concepts in Senate counts. A ballot paper is the physical paper (or the data from the physical paper), while the vote is a value applied to a ballot paper. This value reduces when the ballot paper is involved in electing candidates, and most ballot papers that exhaust do so with a small fraction of a vote remaining. Accordingly there are often many more exhausted ballot papers than exhausted votes. Appendix A on page 10 provides a more detailed discussion of the relationship between ballot papers and votes, as well as some discussion of the principle of 'one vote one value' in Senate elections.

Overall exhaustion in 2016

The 2016 Senate elections had a national vote exhaustion rate of 7.52 per cent, and a national ballot papers exhaustion rate of 49.39 per cent. These represent substantial increases on exhaustion rates under the previous Senate voting system (used between 1984 and 2014). More detail on 2016 exhaustion rates can be found in Table 1 on page 18. As shown in Table 2 page 18, the next highest vote exhaustion rate since 2001 was 0.1 per cent at the 2013 Senate election for Tasmania.

The 2016 increase in exhaustion is due to the change from a FPV system to the new PPV system. This fundamental design difference, with one voting system designed to have no exhausted voting and the second explicitly allowing it, means that there is a substantial break in the time series of exhaustion. This break severely limits comparisons of 2016 exhaustion to exhaustion at previous Senate elections.

In general the larger states had higher levels of exhaustion than the smaller states in 2016. As discussed below, this appears to be related to the number of candidates, parties and groups contesting these elections. In essence, the more candidates there are, the higher the exhaustion rate appears to be, although other factors do also influence the level of exhaustion. More information on these factors can be found in Appendix B on page 12.

In contrast to the states, the territories did not see a marked increase in exhausted votes. The Australian Capital Territory and Northern Territory only elect two Senators each, and the major parties attract high proportions of the first preferences. This means that the territory elections tend to

have fewer distributions of surpluses and exclusions, and thus fewer opportunities for exhaustion to occur.

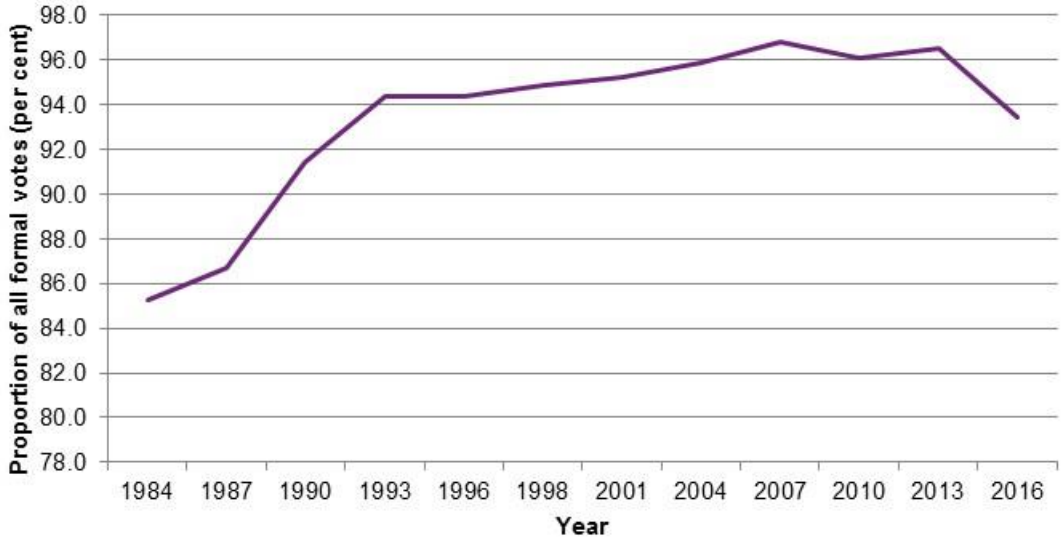
It is also important to note that the 2016 elections were Full Senate elections, with the states electing 12 senators each rather than six (as would be the case in the more usual Half Senate elections). It is difficult to speculate on how exhaustion might change for future Senate elections given the small number of elections run under the new system and the unusual number of vacancies and consequent low quotas in 2016.

Number of options above and below the line

The Senate voting system used from 1984 to 2014 included ticket voting, which was introduced in the 1983 Senate reforms. The 2016 Senate voting system reforms removed ticket voting and allowed electors to express their own preferences both above and below the line. More information on the Above the Line (ATL) and Below the Line (BTL) voting system can be found in Appendix C on page 16. More details on the marking and formality criteria for ATL and BTL voting are provided in Table 3 on page 19.

Since its introduction for the 1984 election, ATL voting has been more popular than BTL voting. However as shown in Figure 1 below, ATL voting in 2016 fell to its lowest level since 1993.

Figure 1. Above the Line voting rates, 1984–2016 Senate elections



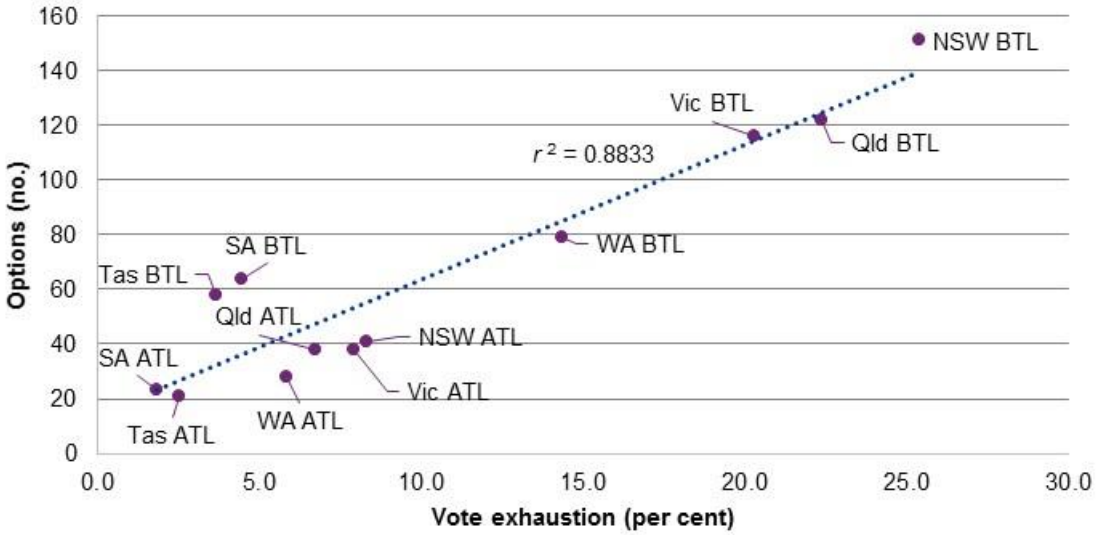
(Australian Electoral Commission, 2016b)

ATL and BTL ballot papers in the 2016 Senate elections exhibited very different levels of exhaustion, as shown in Table 4 on page 19. In all states, BTL ballot papers were more likely to exhaust than ATL ballot papers.

Further, there is an apparent link between the number of groups and ATL exhaustion, and the number of candidates and BTL exhaustion. The relationship may be driven by larger numbers of groups and candidates increasing the effort required to fill out a high proportion of boxes, and by a large number of candidates resulting in an increased opportunity for ballot papers to exhaust. Appendix B on page 12 provides a further discussion of these factors.

Regardless of the factors driving it, it is clear that for both ATL and BTL ballot papers, the more options there are for voters to express their preferences, the higher the vote exhaustion rate tends to be.[4] As shown in Figure 2 below, when the rates of exhaustion for ATL and BTL for each state are compared as separate items, there is a strong apparent relationship between exhaustion rate and the number of options (parties/groups for ATL, candidates for BTL). For 2016, the coefficient of correlation[5] (*r*) between exhaustion rate and number of options is a remarkably high 0.94.

Figure 2. Above the line and below the line vote exhaustion compared to options on ballot paper, 2016 Senate elections for States



(Australian Electoral Commission, 2016a)

While Figure 2 shows a strong linear relationship between exhaustion rates and the number of groups or candidates, there are clearly other factors affecting exhaustion[6].

The relationship between ballot paper exhaustion and vote exhaustion is complex. For example, Tasmania has the lowest level of vote exhaustion of any state, but a higher rate of ballot paper exhaustion than Western Australia or South Australia. The reason that the proportion of exhausted votes is so much lower than the proportion of exhausted ballot papers is that the majority of exhausting ballot papers exhausted with very low transfer values[7], as they had already been involved in the elections of candidates.

By contrast in Western Australia a substantial number of full value ballot papers exhausted in the late stages of counting because they had not been involved in the election of any candidates. This resulted in a relatively high rate of vote exhaustion compared to ballot paper exhaustion.

While the above example may appear counter-intuitive, as ballot papers dictate the movement of fractions of votes, in 2016 there was a homogenising effect on vote exhaustion as counts progressed because ballot papers lose value as candidates are elected.

Regardless of the difference in behaviour between vote and ballot paper exhaustion, exhaustion rates are evidently related to the number of options on the ballot paper (be they parties and groups ATL, or candidates BTL).

The role of exhaustion

Exhaustion is a standard feature of PPV or Optional Preferential Voting (OPV) systems. It can even be a feature of some notionally FPV systems such as the 1983 Senate voting system, albeit on a much lower scale. While, as noted above, an exhausted ballot paper may help to elect one or more candidates, once a ballot paper or vote exhausts it will not affect the election further except by helping to determine the quota[8].

It is therefore easy to conceive of an exhausted ballot paper as lost or wasted, or to think of exhausted votes as being less effective than fully preferenced ballot papers. There is an argument that the more preferences there are on a ballot paper the more 'effective' or 'powerful' it is.

However this is a subjective argument. An exhausted vote is by definition formal, and has expressed the electors stated preferences. An elector may reach the conclusion that if the candidates they have numbered are not elected, they do not wish their vote to assist in the election of any other candidates. This is, potentially, as valuable to an elector as their stated preferences.

It cannot be assumed that an elector wished to express additional preferences, nor that the decision to stop preferencing was taken in ignorance of the possible outcome. Fully preferenced ballot papers may not necessarily contribute to the election of a candidate[9], while (as previously noted) exhausted ballot papers and their votes may have been involved in electing candidates.

The relationship between exhaustion and the number of preferences on the ballot paper is also less clear than it may at first seem. While the number of preferences marked influences the likelihood of exhaustion, any incomplete preference sequence can result in exhaustion. For the 2016 New South Wales Senate election a ballot paper could theoretically have preferenced 150 of the 151 candidates standing (99.4 per cent), with the paper exhausting in the 1,065th count.

Exhaustion can even occur when a ballot paper:

- expressed a preference for all but one candidate,
- never moved from the candidate of first preference, and
- was never involved in an election.

On the other hand a ballot paper with six preferences expressed on it could have been involved in the election of five candidates and still not have exhausted at the end of an election.

Exhaustion and electing without quotas

A quota is the number of votes required for a candidate to be elected. The quota used in both the 1983 and 2016 systems is the Droop quota, which is the smallest number of votes that ensures you cannot elect more candidates than the number of vacancies[10].

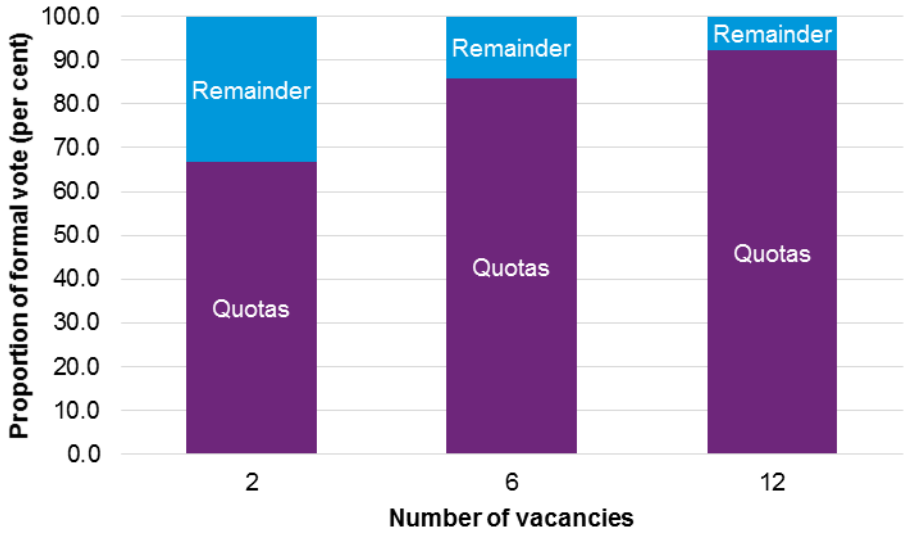
Under pure FPV systems using the Droop quota, all elected candidates will achieve a quota. Under nominally FPV, PPV or OPV systems it is possible that the last candidate (or several candidates) will be elected without achieving a quota due to exhausting votes.

Because the overwhelming majority of ballot papers in the 1983 system (nominally FPV) were fully preferenced, the exhaustion rate was extremely low. Consequently the possibility of candidates being elected without a quota was more theoretical than practical. Under the 2016 PPV system, however, it is not only possible, it occurred in all states other than Western Australia.

The Droop (or similar) quota does not influence the levels of exhaustion. However the proportion of votes that comprise the quotas makes it more or less likely that exhaustion will result in candidates being elected without a quota.

As shown in Figure 3 the proportion of the quotas is determined by the number of vacancies to be filled (i.e. number of candidates to be elected). While fewer vacancies results in higher individual quotas, it also lowers the proportion of the formal votes required to fill all vacancies. This creates a large remainder of votes, which are not needed to elect a candidate. The larger this remainder is, the less likely that exhausted votes will lead to the election of a candidate without a quota.

Figure 3. Proportion of votes remaining after quotas are filled, by number of vacancies



Note: The ACT and NT elect two Senators at each election. The states elect six Senators at half Senate elections, and 12 Senators in a full Senate election.

Appendices

Appendix A. Ballot papers vs. votes

Ballot papers are the physical papers used for elections (or data from the physical papers). Votes are the values added up to determine which candidates are elected, excluded or left over at the end of the election.

The relationship between a ballot paper and a vote is a transfer value. The transfer value is the fraction of a vote that a ballot paper is worth. At the beginning of a Senate count, each ballot paper is worth one vote (i.e. each ballot paper has a transfer value of one).

Candidates are elected when they receive a quota of votes. In most cases an elected candidate will have more votes than is required to meet the quota. The surplus votes need to be moved to another candidate.

For example if the quota is 4,000 votes and an elected candidate has achieved 5,000 votes, they have a surplus of 1,000 votes (votes – quota). These 1,000 votes need to be transferred to another candidate.

The mechanism for moving votes is the movement of ballot papers. In order to account for the quotas that have been achieved, ballot papers that have been involved in an election are moved at a lower transfer value. The transfer is calculated by dividing the surplus votes by the number of ballot papers.

Continuing the above example, the surplus of 1,000 votes is divided by 5,000 ballot papers, giving a transfer value of 0.2.

All of the ballot papers are then distributed to remaining candidates, or exhausted if they cannot be assigned to a remaining candidate. Once the ballot papers are moved, each pile of ballot papers (either for a candidate or excluded) are multiplied by the transfer value. Any remainder is ignored.

Returning to the example, if 100 ballot papers were exhausted at a transfer value of 0.2, 20 votes would exhaust.

It is common for the transfer value of a ballot paper to be less than 0.2. It is therefore also common for each ‘exhausted vote’, as reported in the Distribution of Preferences, to consist of a large number of ballot papers. Accordingly there are usually more exhausted ballot papers than exhausted votes, and an exhausted vote will frequently not be attributable to a single ballot paper.

One Vote, One Value

One of the underlying principles of the Senate voting system is that of ‘one vote, one value’. This is what the transfer value process attempts to achieve.

In essence, a formal ballot paper begins with one vote. If that ballot paper assists in the election of a candidate, it, and all the other ballot papers in that election, reduce in vote value to reflect the portion of their vote that was used to fill the quota.

This principal means, among other things, that:

- Ideally no ballot paper should ever appreciate in vote value during the count process
- All ballot papers should be treated in the same way.

A number of suggestions relating to the concept of one vote, one value have been put forward by psephologists such as Antony Green and Kevin Bonham with regards to the Senate voting system.[11]

One of the most straight forward of these suggestions is the introduction of the Weighted Inclusive Gregory system for the calculation of transfer values.

The current system uses the Unweighted Inclusive Gregory transfer value. Under this system all ballot papers held by a candidate are distributed at the same value during a surplus, regardless of the value they were received at. The overall result is that low value ballot papers increase their value at the expense of higher value papers when subsequently transferred. This can result in large numbers of low value ballot papers effectively swamping high value ballot papers, and distorting the flow of votes.

Weighted Inclusive Gregory removes the possibility of ballot papers gaining in value by taking account of the transfer value a ballot paper is received at. While the Weighted Inclusive Gregory system is more complex (as the number of counts would increase), it is more consistent with the principal of ‘one vote, one value’.

More controversially, in terms of ‘one vote, one value’, a number of systems have been proposed that seek to remove exhausted votes from the system, either by manipulating the quota or by holding exhausted ballot papers during the distribution of a surplus. Some of these approaches (such as leaving exhausted ballot papers with an elected candidate) tend to allow continuing (i.e. not exhausted) ballot papers to appreciate in value. These approaches can also treat exhausted ballot papers differently to continuing papers, by co-opting their portion of a vote into preferences expressed on other ballot papers by other electors, or by inflating the value of continuing ballot papers because the quota reduces. Discussions around adopting these systems should take this into consideration.

Appendix B. Factors influencing levels of exhaustion

The degree of exhaustion will depend on a number of factors, including:

- The voting system
- The numbers of preferences expressed by voters
- The number of candidates and groups
- Concentrations of votes
- Position in the counting process at time of transfer.

The interaction of these factors, and others such as campaigning and elector interest in politics, is complex. Nonetheless these factors are some of the principle mechanisms affecting exhaustion.

The voting system

Exhaustion is a normal part of OPV and PPV/OPV systems, and existed in the FPV system used between 1984 and 2014. In their purest forms:

- OPV allows a voter to choose how many preferences to express after a single 1
  - this means that the voter is not forced to express preferences they do not hold
  - can result in high levels of exhaustion
- PPV allows an elector to choose how many preferences to express after a set minimum
  - is less likely to force voters to preference when they either have no preference, or do not wish to elect any of the remaining candidates
  - encourages movement of ballot papers, and will therefore usually result in less exhaustion than an OPV system, and more than a FPV system
- FPV, in contrast to the above voting systems, requires electors to mark all candidates[12]
  - forces the expression of preferences where a voter either has no preference, or does not wish to elect any of the remaining candidates[13]
  - ensures that the elected candidates are the most preferred (or least disliked) candidates
  - removes or drastically reduces exhaustion.

The number of preferences expressed by voters

Exhaustion occurs when there are no further candidates to move a ballot paper to. Therefore the more preferences a ballot paper has on it the less likely it is to exhaust.

The minimum preference requirements in place for the 2016 Senate elections ensured a degree of movement of ballot papers, and, in conjunction with other features of the elections, served to minimise the incidence of exhaustion.

However the number of preferences has a complex relationship with other factors, notably the concentrations of votes and the way in which ballot papers and votes move during the count.

Nonetheless if an elector is concerned about their ballot paper exhausting under a PPV or OPV system, they can preference all candidates or groups to prevent it exhausting.

The number of candidates and groups

As noted in the body of this paper, the number of options appears to have an effect on exhaustion levels. While the relationship is not strictly linear, and more data are needed, it currently appears that having more options on the ballot paper increases the rate of vote exhaustion (although the relationship with ballot paper exhaustion is less clear).

The larger the number of options, the greater the barrier to filling in a high proportion of the ballot paper. The larger the number of candidates, the more likelihood that late elected or excluded candidates ballot papers will exhaust because options for continuing candidates are removed.

If an election has 12 or fewer candidates (or six or fewer groups), exhaustion would be expected to reduce to around pre-2016 levels. This is because the minimum number of preferences would be greater than the number of options available, effectively making the election FPV. On the basis of history such a low number of options is only likely to occur in the territories, although tighter nomination processes (through legislation) or parties adjusting to the new voting system could make this more likely in the future.

The size of quotas

The size of the quota as a proportion of the overall number of votes may have some relationship to exhaustion rates, although this interaction is complex.

Larger quotas are likely to discourage some candidates from standing. Additionally, because larger quotas are the result from there being fewer vacancies to fill, they would tend to result in shorter count processes, which in turn would reduce the opportunities for ballot papers to exhaust.

Preliminary testing of a hypothetical half-Senate election using the 2016 Senate ballot papers reduced exhaustion nationally, and in most states (in some cases quite substantially). However two states had an increase in their levels of exhaustion, and the other factors discussed here clearly had an impact.

Concentrations of votes

The concentration of votes, primarily by candidate but also by party, is the central driver of the degree of movement of ballot papers and votes. It determines which candidates are elected, excluded, or remain after the election is concluded.

Highly concentrated voting, where a small number of parties have multiple quotas each, will tend to result in a short counting process, unless the last vacancies are slow to resolve. Short counting processes tend to have fewer opportunities for ballot papers to exhaust. Additionally, if the majority of ballot papers exhausting have already been involved in multiple elections (for example by electing multiple candidates from one ticket), the number of exhausted votes will tend to be lower when compared to the number of exhausted ballot papers. Small concentrations of votes should have the opposite effect.

Position in the counting process at time of transfer

Ballot papers that are transferred (by distribution of a surplus or by exclusion) in later counts are more likely to be exhausted. This is due to two principle factors:

- in order to be formal a ballot paper must express a minimum number of preferences, and during the early stages of the counting, when a fair number of candidates are elected on first preferences or the distributions of early surpluses, papers are unlikely to run out of preferences
- conversely, in the late stages of the count most candidates have either been excluded or elected, and are therefore ineligible to receive more ballot papers, so even a ballot paper with a relatively high proportion of validly expressed preferences is likely to exhaust.

While these factors can be seen in any of the 2016 state Senate elections, the latter is most notable in the 2016 Western Australian Senate election.

At the end of the Western Australian election only three candidates remained to fill two vacancies. The final count of the Western Australian election was the exclusion of Kado Muir on The Nationals ticket, who had fewer votes than The Greens (WA) and Pauline Hanson's One Nation parties.

The Nationals had attracted 34,618 (2.5 per cent) of the first preference votes, with most of that going to Muir. At the point of exclusion Muir held 67,657 votes (64.4 per cent of a quota), of which 65,112 were full value ballot papers (a gain of 30,494 full value ballot papers and 2,545 votes from ballot papers at less than full value).

The full value ballot papers were transferred at count 539, with 14,236 going to Siewert (The Greens), 14,153 to Culleton (Pauline Hanson's One Nation), and the remaining 36,723, which had no other candidates to be distributed to, exhausted. The transfer was sufficient to elect Siewert and Culleton, so the election halted at that point with the remaining ballot papers (which were at less than full value) not being distributed.

Exhaustion in final counts

The election system requires the counting to continue until either all vacancies are filled by candidates elected with quotas, or for candidates to be excluded until only sufficient candidates

remain to fill the remaining vacancies. Because a candidate cannot receive votes (or ballot papers) after they are excluded or elected, counts will sometimes end before all ballot papers have been transferred (as occurred in the 2016 Western Australian Senate election, in which the last excluded candidate only had their full value votes transferred).

Current AEC practice is to 'complete' the counting process as far as practicable, which is used to establish the order of election. However as both Kevin Bonham and Antony Green have identified[14], counting to completion can often mean that the result is known before the counting process is finalised.[15] When taken in conjunction with the fact that a substantial amount of exhaustion usually occurs in the final counts, this means that some of the exhaustion reported in the counting process does not need to occur.

This final stage exhaustion has little material effect on an election. It cannot change who is elected, and while the way in which the end of a counting process is conducted could affect the order of the final candidates, it is unlikely to do so. The order of the final candidates is also of limited practical value, as the principal use of order of election is to provide advice regarding which Senators should be assigned three or six year terms following a full Senate election[16].

For the 2016 Senate elections, if the count had stopped as soon as it was known who would fill the final vacancies, vote exhaustion would have dropped from 7.5 per cent nationally to 5.08 per cent. This change would have been driven by lower exhaustion rates in New South Wales, Victoria, Queensland and Western Australia. The other states and territories were not affected by this issue in 2016. Further details can be found in Table 6 on page 20.

Appendix C. ATL/BTL voting and the Group Voting Ticket

The 1983 Senate voting reforms introduced ticket voting to the Australian Senate voting system in an effort to address extremely high levels of informal voting for the Senate. Where previously electors were required to number all candidates, the new system added the option of voting using a ticket (preference order) lodged by a political party or group; this was called a Group Voting Ticket (GVT). Subsequent reforms allowed parties and groups to submit up to three GVTs, with the resulting possibility of ticket votes being split two or three ways.

To facilitate GVT voting, Senate ballot papers were divided by a horizontal line into Above the Line (ATL) and Below the Line (BTL) parts. The ATL part of the ballot paper allowed the elector to vote according to a GVT, while the BTL part allowed the elector to control their preferences directly. BTL voting required significantly more effort than ATL voting, as all candidates were theoretically required to be numbered, potentially requiring as many as 110 numbers to be written. In comparison, only a single '1' was required for ATL voting.

The ease of voting ATL (and hence for a GVT) was a likely factor in its popularity compared to BTL voting. The popularity of ATL voting, the ability to create advantageous preferences deals with other groups, and the fact that lodging a GVT were the only ways to get an ATL box, created an incentive for candidates to form parties and groups. It also led to the phenomenon of 'preference harvesting', a subject of substantial debate (particularly following the 2013 Senate elections) and one of the reasons for the 2016 Senate voting system reforms.[17] Combined with the ease and popularity of ATL voting, this was seen by some as a major distortion in the Senate voting system.

The previous Senate system was also critiqued on the grounds that it was biased in favour of ATL voting. In elections with a large number of candidates it was difficult for electors to make an informed decision when many parties and candidates were unknown to them (and in some instances were difficult to locate information on). This was compounded by the high number of candidates making BTL voting unattractive, as well as increasing the chance of accidentally voting informally. In a Joint Standing Committee on Electoral Matters hearing psephologist Antony Green told the committee that the complexity created a herding effect, pushing electors into voting above the line (Joint Standing Committee on Electoral Matters, 2016).

There are a number of features of ATL and BTL under the 1983 and 2016 systems that are not immediately obvious.

Under the 1983 system (with some follow up reform):

- Split GVTs allowed parties, groups and electors to effectively not preference a major party, an option not available to below the line voters
- A formal ATL vote with an associated GVT could not exhaust as all candidates had to be included in the GVT

- The savings provisions for BTL voting allowed BTL voters to effectively cast an OPV vote

Under the 2016 system:

- The degree of choice given to the elector (arguably the value of the optional component to preferencing) varies due to:
  - The number of candidates (with the territories having far fewer groups and candidates, but the same instructions and formality requirements)
  - The number of candidates by group (it being possible for a single '1' ATL to be the equivalent of anywhere between two and 12 BTL preferences, and formal at any point)
- A complete numbering of all boxes ATL does not ensure that a ballot paper will not exhaust since ungrouped candidates cannot be preferenced ATL.

Appendix D. Tables

Table 1. Ballot paper and vote exhaustion, 2016 Senate elections

State/territory	Formal votes no.	Ballot paper exhaustion no.	Ballot paper exhaustion %	Vote exhaustion no.	Vote exhaustion %
NSW	4,492,197	2,712,475	60.38	414,656	9.23
Vic.	3,500,237	1,802,642	51.50	300,283	8.58
Qld.	2,723,166	1,862,406	68.39	208,964	7.67
WA	1,366,182	206,597	15.12	85,766	6.28
SA	1,061,165	142,605	13.44	21,556	2.03
Tas.	339,159	108,617	32.03	9,531	2.81
ACT	254,767	109	0.04	109	0.04
NT	102,027	0	0	0	0.00
Total	**13,838,900**	**6,835,451**	**49.39**	**1,040,865**	**7.52**

(Australian Electoral Commission, 2016a)

Table 2. Exhausted vote percentages, 2001–2016 Senate elections

State/territory	2001 %	2004 %	2007 %	2010 %	2013 %	2016 %
NSW	0.04	0.05	0.01	0.04	0.04	9.23
Vic	0.04	0.04	0.02	0.04	0.06	8.58
Qld	0.02	0.09	0.04	0.04	0.04	7.67
WA	0.07	0.03	0.02	0.01	0.07	6.28
SA	0.01	0.05	0.02	0.03	0.05	2.03
Tas.	0.09	0.06	0.07	0.08	0.10	2.81
ACT	N/A	N/A	N/A	0.00	0.03	0.04
NT	N/A	N/A	N/A	N/A	0.02	N/A
Total	**0.04**	**0.05**	**0.02**	**0.04**	**0.05**	**7.52**

(Australian Electoral Commission, 2016b)

Table 3. Correct marking and formality criteria for Senate elections

System	Correct marking	Formality criteria
1983 ATL	A single number 1 above the line	A single number 1 above the line
1983 BTL	An uninterrupted sequence from 1 to the end of the candidates	A sequence starting with a single number 1, and if there are 10 or more candidates: ■ At least 90 per cent of the ballot paper filled in ■ No more than three corrections required to create an interrupted sequence, ignoring repeats If there are 9 or fewer candidates: ■ No more than three corrections required to create an interrupted sequence, ignoring repeats
2016 ATL	An uninterrupted sequence from 1-6, or higher	A single number 1 above the line
2016 BTL	An uninterrupted sequence from 1-12, or higher	An uninterrupted sequence from 1-6 below the line, with no repeated numbers

Commonwealth Electoral Act, 1918

Table 4. Above and Below the Line exhaustion, 2016 Senate elections

			Ballot paper exhaustion			Vote exhaustion		
State/territory	ATL no.	BTL no.	ATL %	BTL %	Total %	ATL %	BTL %	Total %
NSW	4,249,550	242,647	58.87	86.94	60.38	8.31	25.39	9.23
Vic.	3,314,376	185,861	50.04	77.61	51.50	7.93	20.28	8.58
Qld.	2,555,956	167,210	67.92	75.64	68.39	6.72	22.37	7.68
WA	1,290,839	75,343	14.25	30.12	15.12	5.81	14.38	6.28
SA	970,934	90,231	12.24	26.36	13.44	1.82	4.42	2.04
Tas.	243,774	95,385	29.73	37.90	32.03	2.50	3.64	2.82
ACT	216,086	38,681	0.05	0.01	0.04	0.05	0.01	0.04
NT	93,277	8,750	0	0	0	0.00	0.00	0.00
Total	**12,934,792**	**904,108**	**48.48**	**62.42**	**49.39**	**6.85**	**17.15**	**7.53**

(Australian Electoral Commission, 2016a)

Note: Percentages are approximate, based on the transfer values of candidate ballot papers at the time of exhaustion. The calculations are sensitive to assumptions, and are intended as a general guide only.

Table 5. Number of candidates exhausted ballot papers helped to elect, 2016 Senate elections

State/territory	0 no.	1 no.	2 no.	3 no.	4 no.	5 no.	6 no.	Total no.
NSW	360,078	725,702	75,799	8,865	639,808	902,195	28	2,712,475
Vic.	275,281	319,326	343,323	5,354	297,279	515,490	46,589	1,802,642
Qld.	183,493	247,167	159,455	13,296	536,882	589,721	132,392	1,862,406
WA	83,600	18,580	2,043	1,097	42,592	47,580	11,105	206,597
SA	15,694	28,151	4,047	40,604	26,653	27,456	0	142,605
Tas.	5,412	26,126	12,893	2,632	37,887	23,667	0	108,617
ACT	109	0	0	0	0	0	0	109
NT	0	0	0	0	0	0	0	0
Total	**923,667**	**1,365,052**	**597,560**	**71,848**	**1,581,101**	**2,106,109**	**190,114**	**6,835,451**

(Australian Electoral Commission, 2016a)

Table 6. Vote exhaustion, 2016 Distributions of Preferences vs. point when elected candidate is known

State/territory	Formal votes no.	From end of Dist. Of Pref. no.	 %	Candidates known no.	 %	Difference %
NSW	4,492,197	414,656	9.23	326,849	7.28	1.95
Vic.	3,500,237	300,283	8.58	180,896	5.17	3.41
Qld.	2,723,166	208,964	7.67	115,685	4.25	3.42
WA	1,366,182	85,766	6.28	49,043	3.59	2.69
SA	1,061,165	21,556	2.03	21,556	2.03	0.00
Tas.	339,159	9,531	2.81	9,531	2.81	0.00
ACT	254,767	109	0.04	109	0.04	0.00
NT	102,027	0	0.00	0	0.00	0.00
Total	**13,838,900**	**1,040,865**	**7.52**	**703,699**	**5.08**	**2.44**

(Australian Electoral Commission, 2016a; 2016c)

References

Australian Electoral Commission. (2016a). Ballot paper scanning data, 2016 Senate elections.

Australian Electoral Commission. (2016b). Historical Election Statistics Archive. Strategic Research and Analysis Section, Internal electronic resource.

Australian Electoral Commission. (2016c). *Tally Room, 2016 Federal Election*. Retrieved November 8, 2016, from http://results.aec.gov.au/20499/Website/HouseDefault-20499.htm

Bonham, K. (2016). *Submission to the Joint Standing Commission on Electoral Matters: Inquiry into and report on all aspects of the 2016 Federal Election and matters related thereto.* Submission 74, JSCEM Inquiry into and report on all aspects of the 2016 Federal Election and matters related thereto. Retrieved December 23, 2016, from http://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Electoral_Matters/2016Election/Submissions

Green, A. (2016). *Submission to the Commonwealth Joint Standing Committee on Electoral Matters Inquiry into the conduct of the 2016 Federal Election.* Submission 30, JSCEM Inquiry into and report on all aspects of the 2016 Federal Election and matters related thereto. Retrieved December 23, 2016, from http://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Electoral_Matters/2016Election/Submissions

Joint Standing Committee on Electoral Matters. (2016, March 1). *Official Committee Hansard.* Public hearing for the JSCEM Inquiry into the Commonwealth Electoral Amendment Bill 2016. Retrieved December 22, 2016, from http://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Electoral_Matters/CEAB2016/Public_Hearings

End notes

[1] The previous Senate voting system was not strictly Full Preferential Voting due to savings provisions that allowed some ballot papers to be counted as formal without a full valid number sequence.

[2] The 2016 voting system is referred to in the explanatory memoranda for Commonwealth Electoral Amendment Bill 2016 as being a partial optional preferential voting system, with no capitalisation or provided acronym. However the Electoral Council of Australia and New Zealand refers to this type of system as Partial Preferential Voting (PPV). In accordance with the established naming convention, this report uses the term PPV.

[3] Due to changes in the Senate voting system, 2016 exhaustion is not strictly comparable with exhaustion in previous Senate elections. However some people may wish to compare 2016 with previous exhaustion rates for the purposes of comparing the voting systems. While such a comparison is beyond the scope of this paper, Table 2 provides a basis for comparing exhaustion rates between 2001 and 2016.

[4] The territories are excluded from discussion of exhaustion with numbers of groups and candidates. This is because the difference between states and territories in vacancies, and therefore quotas, limits the usefulness of comparing state and territory exhaustion.

[5] Pearson product-movement correlation coefficients (denoted by *r*, with a value between –1 and +1) are used to measure the strength of the linear relationship between two variables.

[6] The number of options explains around 88 per cent of the variation in vote exhaustion, with an r^2 of 0.8833. However the relationship is less straight forward when considering ballot paper exhaustion, and there is some variation in vote exhaustion noted later. (The square of the Pearson's *r* (denoted by r^2) measures the proportion of the total variation in one variable that is explained by variation in the other variable.)

[7] The transfer value is the proportion of a vote that the ballot paper is worth, adjusted each time the ballot paper is involved in electing a candidate. The transfer value starts at 1, meaning the ballot paper is worth one vote, and then reduces as discussed in Appendix A on page 11.

[8] The quota is the number of votes required for a candidate to be elected. Quotas are discussed further in Exhaustion and electing without quotas on page 9.

[9] A fully preferenced ballot paper does not guarantee that a ballot paper will elect a candidate, as a ballot paper might sit with the candidate of first preference until the final vacancy is filled without moving. In the 1983 system this was not even particularly uncommon, particularly in the territory Senate elections.

The territories, with only two vacancies, would often finish after a short counting process, or even be decided on first preferences. In 2016 the Northern Territory had no exhausted ballot papers in spite of the adoption of PPV, due to both vacancies being filled on first preferences.

In the context of a discussion about 'wasted' votes, 26.7 per cent of the 2016 Northern Territory votes were not involved in an election. The difference between this and an exhaustion rate of 26.7 per cent is a matter of perspective.

[10] The Droop quota divides the number of formal votes by the number of vacancies plus one, and then adds one. It can be expressed as:

$$\frac{Formal\ votes}{Number\ of\ vacancies + 1} + 1 = Droop\ quota$$

The Droop quota is also effectively used for the House of Representatives, although the House quota is usually expressed as 50% + 1. Because the House of Representatives system is pure FPV it has no exhaustion. However the very low high quota allows over 49 per cent of the vote to not count towards electing a candidate.

[11] For example, in their submissions to the 2016 Joint Standing Committee on Electoral Matters' (JSCEM) inquiry into the 2016 federal election. (Bonham, 2016; Green, 2016)

[12] In the previous FPV Senate count system, exhausted ballot papers occurred when a savings provision was used to allow the inclusion of a ballot paper with an interrupted number sequence. Without the savings provisions, any interruption in the number sequence would have rendered the ballot paper informal.

Notably, electors who understood the savings provisions could effectively cast an OPV vote by making an 'error' in their numbering at any point, and then continuing a formal normal sequence. The necessary degree of understanding to make use of the savings provisions in this way, and the desire to do so, appear to have been rare, as demonstrated by the low number of exhausted votes, which would have included unintentional errors.

[13] In the FPV Senate system used for elections between 1984 and 2014, Group Voting Tickets (GVT) were used to facilitate above the line voting. GVTs were lodged by parties or groups, and were a prerequisite for receiving a box above the line. All above the line votes for that party or group would be distributed according to the GVT, although parties could lodge up to three GVTs to prevent their votes from flowing to only one of the major parties. Split GVTs therefore allowed parties, groups and electors to effectively not preference a major party, an option not available to below the line voters.

GVTs were supplied in polling places (and, later, online) to allow electors to examine them. This system was critiqued on a number of grounds, the most notable relating to the potential for 'preference harvesting' or 'gaming' of the system.

The FPV system was also critiqued on the grounds that it was biased in favour of ATL voting. In elections with a large number of candidates it was difficult for electors to make an informed decision when many parties and candidates were unknown to them (and in some instances were difficult to locate information on). This was compounded by the number of candidates making below the line voting unattractive (as well as increasing the chance of accidentally voting informally). In a Joint Standing Committee on Electoral Matters hearing psephologist Antony Green told the committee that the complexity created a herding effect, pushing electors into voting above the line. (Green, 2016)

[14] In their submissions to 2016 JSCEM inquiry into the 2016 federal election. (Bonham, 2016; Green, 2016)

[15] This would not result in the Senate count being finished noticeably earlier in a computerised count, in which the last few counts might take a few seconds. In a manual count, however, it could save days of counting.

[16] A full Senate election occurs when the whole Senate is dissolved in a Double Dissolution. In a full Senate election each state elects 12 senators rather than six. In order to return the Senate to rolling elections after a full Senate election half of the elected senators are assigned to a six year term, and the other half to a three year term. Section 282 of the *Commonwealth Electoral Act 2018* requires the AEC to recount a full Senate election excluding all candidates who were not elected in the first election. However the Senate is not bound by the outcome of a s.282 recount results.
The s.282 recount system was designed for the previous Senate voting system, and was not updated for the new system.

[17] The most notable critique of the previous system that arose in the debate about the 2016 reforms was that GVTs gave parties and groups the ability to allocate preferences rather than the voter. Because GVTs and their interaction with the counting system were poorly understood, this allowed 'preference harvesting' and 'gaming' of the system. It also allowed candidates with small numbers of votes to 'leapfrog' other candidates who had a higher number of votes (although, again, there were misunderstandings about this interaction).