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Voters and Politicians: three papers in applied political-economics

by Eamon Gilbert McGinn

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

under the supervision of Shiko Maruyama, Peter Siminski, and Kentaro Tomoeda

University of Technology Sydney
UTS Business School
Economics Discipline Group

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Certificate of original authorship

I, Eamon McGinn, declare that this thesis is submitted in fulfillment of the requirements for the award of Doctor of Philosophy, in the Business School at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise indicated in the references or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

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This is a thesis by compilation, as of submission for examination, no chapter has been submitted for publication. Chapter 1 was co-authored with Shiko Maruyama. This thesis has been copy-edited and proof-read by Abigail Bergman.

ELECTION
VOTE
Vote Now
Go Vote!
Vote
Election
Election Day
Vote to Win!
20%
80%
I Voted!
NEWS
Vote Now
I Voted!
Need Your Vote!
I Voted
Vote Day!
Vote
Vote to Win!
Vote Results
Election Day
Register to Vote!

This thesis is dedicated to Holly and Astrid.

Abstract

This thesis consists of three papers unified by a common focus on the behavior of voters and politicians in elections.

Chapter 1 considers informal voting in Australian elections. In Australia, there are around5-6% of voters who submit an informal vote, which doesn't count towards the total. In this chapter, I make use of a natural experiment, based on exogenous changes in electorate boundaries, to identify what factors influence the number of informal votes. I find that factors that feature in the traditional theory on voter decisions, competitiveness and number of other voters, do not affect the rate of informal voting. Instead I find that more candidates on the ballot results in higher levels of informal voting. Halving the number of options would reduce informal voting by 27%. This effect is present regardless of the level of education, indicating it is likely a decision to abstain rather than an error.

Chapter 2, deals with the role of politicians' personal ideology in determining their voting behaviour. I extend recent empirical findings by applying a text-as-data approach to analyse speeches in parliament following a recent politically charged moment in Australia –- a national survey on same sex marriage (SSM). I estimate opposition to SSM in parliamentary speeches and measure how speech changed following the SSM vote. I find that Opposers of SSM became stronger in their opposition once the results of the national survey were released,

regardless of how their electorate voted. No consistent and statistically significant change is seen in the behavior of Supporters of SSM. This result indicates that personal ideology played a more significant role in determining changes in speech than did the position of the electorate.

In Chapter 3, I analyze the transition to instant run-off voting (IRV) that is occurring in some jurisdictions in the U.S. There are mixed findings in the literature on the benefits of IRV for voters and politicians, making informed debate around its adoption challenging. Analysis of the Minneapolis-St. Paul Metro Area, which has strong natural experiment characteristics, indicates that the introduction of IRV caused a 9.6 percentage point increase in turnout for Mayoral elections. The effect is larger for precincts that have higher poverty rates. Text based sentiment analysis of mayoral debates across the U.S., a new approach in this area, indicates that the introduction of IRV improved the civility of debates with candidates substituting negative or neutral words for positive words.

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Introduction

This thesis consists of three separate papers that are unified by a common focus on the behavior of voters and politicians in elections.

Chapter 1 considers informal voting in Australian elections. In Australia, which is one of the few developed countries where voting is compulsory, around 5-6% of votes in recent elections are determined to be "informal", because they are empty or improperly filled in, and so don't count towards the outcome of the election.

This paper offers a better understanding of voting behavior by making use of a natural experiment that arises in the Australian electoral system. In Australia, an independent commission makes changes to the boundaries of electoral divisions. These boundary changes result in some voters experiencing a drastic exogenous change in the nature of the election – competitiveness, number of voters and number of candidates all change. This exogenous change allows us to quantify the causal effects of the three important factors contributing to the rate of informal votes: the competitiveness of the electoral division, the number of voters in the electoral division, and the number of options shown on the ballot. This paper also contributes to the literature on voter turnout as the identification approach means we can abstract from travel costs to quantitatively compare alternative hypotheses on voter behavior, which isn't possible in other papers that focus on voter turnout in other contexts.

We find that factors that feature in the traditional theory on voter decisions, competitiveness, and number of other voters, do not affect the rate of informal voting as predicted. Instead we find that more candidates on the ballot results in higher levels of informal voting. Using the results, a back of the envelope calculation indicates that, if the number of options on each ballot were reduced by half then the total number of observed informal votes in the data would be reduced by 27%, and the share of informal votes would fall from 5.4% in total to 3.9%.[1] This effect is important because, from 2004-2016, around 32% of contests had more informal votes than the margin. Policies that affect the level of informal voting across a large number of voters may, therefore, affect the final composition of parliament. These findings are robust across model specifications and subgroups within the data.

In Chapter 2, I analyze the a national vote held in Australia in 2017 on whether Same Sex Marriage (SSM) should be legalised. The national vote provided politicians with new and thorough information on the position of their electorate with respect to SSM. The national vote was followed by a brief period where politicians debated SSM legislation in parliament with a high level of scrutiny from the media and voters. The national vote therefore involved a fast, clear and closely monitored method of communication between the electorate and politicians where new information was made available to politicians on a single, politically charged

[1] This back of the envelope calculation does not take into account other effects that would likely happen in a real world situation where the number of candidates is halved, such as changes in the political positions of the candidates or their electoral strategies.

topic. In contrast, most feedback between electorates and politicians is slow, involves complex policy spaces and is often not well reported or monitored by the public at large. The context and results of the SSM national survey provide a unique opportunity to identify the role that ideology and the position of the electorate play in determining the behavior and decisions of politicians.

The approach to the analysis makes use of the text-based techniques. I start with data on the known stance of politicians on the issue of SSM. Parliamentary speeches are then processed into a large and sparse matrix representing the speech as data. A LASSO model is then used to select the phrases that are most important for predicting whether a speech is given by a representative known to support or oppose SSM. The fitted value for each speech is used to assign a score on how likely the speech is to have been delivered by a supporter of SSM. The fitted scores for each speech are then used in further reduced form analysis which directly addresses the question of how representatives responded to their electorate's position as expressed through the national survey on SSM. The results of the analysis indicate that Opposers of SSM tended to become stronger in their opposition to SSM once the results of the SSM national survey were released – the average Opposer increased their opposition by 0.15-0.2 on a scale of 0-1. This strengthening of opposition occurred regardless of the position of their electorate. No consistent and statistically significant change is seen in the behavior of Supporters of SSM. This result indicates that personal ideology played a more significant role in determining political behavior than did the position of the electorate.

In Chapter 3, I analyze the transition to instant run-off voting (IRV) that is occurring in some jurisdictions in the U.S. Currently, IRV is only used in a small number of municipal elections in the U.S. but this number has grown significantly over the last ten years. The resurgence is based on a range of expected benefits including: ensuring majority support for elected candidates, reducing costs of running elections, increasing civility between candidates, reducing conflict within the electorate, reducing strategic effects for voters and increasing diversity of candidates and elected representatives. These direct benefits have also been expected to translate into an increase in voter turnout.

A sizable literature has developed analyzing the various purported benefits of IRV. There is actually mounting evidence in this literature that IRV has not been living up to expectations in many areas. This chapter seeks to address two particular areas of potential benefit of IRV that have mixed results and weak methodologies in the existing literature: increasing turnout and improving civility. While this paper doesn't focus on the theoretical reasons for the relationship between IRV, turnout and civility, some intuition is possible. Under IRV, voters can vote for their most preferred candidate without worrying about whether their vote will be 'wasted', which could lead to higher turnout. Also, under IRV, negative campaigning could turn voters away from placing a candidate second or third in their ranking and so candidates may use more positive communication styles.

To analyze turnout, I use the difference-in-differences approach to focus on an in-depth analysis of the Minneapolis-St. Paul Metro Area, where the common trends assumption is likely to hold and can be more carefully analyzed. The results of the analysis indicate that, in the Minneapolis-St. Paul Metro Area, the introduction of IRV caused a 9.6 percentage point increase in turnout for Mayoral elections. The effect on turnout is larger for precincts that have higher poverty rates.

To analyze civility, I use a modern, natural language processing approach that impartially analyses the civility of debates. This can provide a more precise quantification of the effect of IRV on civility during campaigns than previous research, which have used surveys or interviews. This text based sentiment analysis is applied to mayoral debates in a broader set of cities across the U.S. and indicates that the introduction of IRV improved the civility of debates. The improvement in civility is due to candidates substituting negative or neutral words for more positive words throughout the debate.

I conclude with Chapter 4, in which the key findings are summarized and ideas for future areas of research are outlined.

While the three chapters are separate, they are unified by a common focus on the behavior of voters and politicians in elections and some common themes emerge. There are multiple results that indicate that voters and politicians don't behave as would be expected given simple economic models of their behavior. The results indicate that voters and politicians are affected by a very broad range of factors that include mental processing costs, personal ideology and the type of election being used. These factors are not directly related to the core of basic economic models of voter and politician behavior, which largely focus on the benefits of having a preferred policy implemented. The results therefore indicate some of the many facets that are needed to fully understand and model voter and politician behavior.

1

Informal voting in compulsory elections in Australia

In Australia, one of the few developed countries where voting is compulsory, around 5-6% of votes in recent elections are determined to be "informal", because they are empty or improperly filled in, and so don't count towards the outcome of the election.

Why would a voter who has already travelled to the polls and queued up to get their ballot submit and informal vote? Informal votes are a major issue as high rates can cause concerns about the legitimacy of a government (Lijphart, 1998) and can disproportionately affect disadvantaged citizens, leading to unequal influence (Kawai et al., 2020).

This paper offers a better understanding of why voters submit informal ballots by making use of a natural experiment that arises in the Australian electoral system. In Australia, an independent commission makes changes to the boundaries of electorates. These boundary changes result in some voters experiencing a drastic exogenous change in the nature of the election – competitiveness, number of voters, and number of candidates all change. This allows us to quantify the causal effects of these three factors contributing to the rate of informal votes.

This paper also contributes to the literature on voter turnout. Analysing the impacts of travel costs on turnout has been done causally in papers such as Funk (2010) Godefroy & Henry (2016), Schelker & Schneiter (2017) and non-casually in papers such as Gimpel & Schuknecht (2003) and Haspel & Knotts (2005). These papers generally find that there is an increase in turnout when costs are decreased. Our identification approach means we can put aside the issue of travel costs to quantitatively compare alternative hypotheses on voter behavior. Such a treatment of travel costs is not possible in other papers that focus on voter turnout in other contexts.

This paper contributes to the large literature on the relationship between voting behavior and socio-economic status of voters (Geys (2006) and Cancela & Geys (2016) provide a thorough review of the literature) by considering how different subgroups respond to exogenous changes in the competitiveness of the electorate, the number of voters in the electorate, and the number of options shown on the ballot.

The empirical literature on voter turnout, which builds on theoretical work from Downs (1957), Riker & Ordeshook (1968), and Palfrey & Rosenthal (1985), generally identifies three key determinants of voter turnout and informal votes: a voter is more likely to vote in a smaller electorate, when there is expected to be a close margin between the winner and the runner up, and when travel and time costs are low (Levine & Palfrey, 2007). The general finding in the empirical literature is supported, although mixed, for the expected relationships from the theory [see literature reviews by Geys (2006), Blais (2006), Cancela & Geys (2016), and Stockemer (2017)]. These results are generally confirmed by papers with a focus on causal analysis such as Fauvelle-Aymar & François (2006), Indridason (2008), De Paola & Scoppa (2014), and Garmann (2014), which all find that competitiveness increases turnout; and Lyytikäinen & Tukiainen (2019) who find that an increase in the number of voters in an electorate decreases turnout. In contrast, Matsusaka (1993), using random variation in ballot propositions on the same ballot, finds that there is no relationship between closeness and turnout.

An alternative explanation for voter turnout and informal voting behavior is that voters are averse to the mental processing costs associated with correctly completing a ballot. Horiuchi & Lange (2019), Cunow (2014), and Augenblick & Nicholson (2016) show that, when presented with more candidates, voters abstain from voting, reduce the dimensionality of the issue space, and make voting errors.

In a completely different approach, Feddersen & Pesendorfer (1996) build a theoretical model where uninformed voters may choose to abstain in order to allow informed voters to control the outcome of the election. This model has received empirical support in lab experiments (Battaglini et al., 2008) and in natural experiments (Lassen, 2005).

There is also considerable disagreement on what causes informal voting. In causal analysis, De Paola & Scoppa (2014) find that closeness has no effect on informal voting. This is different to non-causal studies, such as Galatas (2008), which generally find that closer elections have lower levels of informal voting, the expected relationship. In non-causal analyses, Power & Garand (2007) find that social, personal, and institutional factors contribute to the level of informal voting in South America. In contrast, Driscoll & Nelson (2014) attribute informal voting in South America primarily to political concerns. In Australia, Hill & Young (2006) conclude that informal voting is related to the complexity of voting and high levels of voter turnout due to compulsory voting. This aligns with analysis by Nagler (2015), who uses time series data, and shows that more candidates on the ballot is associated with more informal votes. Causal analysis of Swiss elections by Hoffman et al. (2017), who also find that compulsory voting increases the level of informal voting.

In an advance from the existing literature, we make use of a natural experiment, based on exogenous changes in electorate boundaries, to identify a range of potential contributing factors that influence the rate of informal voting. These contributing factors are tested together, in a single model, and with causal interpretation. Directly testing and comparing these different factors is important because they have different implications for any policy that may be aimed at increasing formal voting.

We find that factors that feature in the traditional theory on voter decisions, competitiveness, and number of other voters, do not affect the rate of informal voting as predicted. Instead, akin to hill2006cause, we find that more candidates on the ballot results in higher levels of informal voting. Using the results, a back of the envelope calculation indicates that, if the number of options on each ballot were reduced by half then the total number of observed informal votes in the data would be reduced by 27%, and the share of informal votes would fall from 5.4% in total to 3.9%.[1]

One subgroup, areas with high levels of tertiary education, is of particular interest. Informal votes are less prevalent in these better-educated areas and voters are more strategic, reacting to the competitiveness of their electorate as predicted by theory. Surprisingly, voters in these better educated areas still respond to the number of options in the same way as other voters, indicating that this behavior is not explained by differences in levels of education. This finding is supported by additional, non-causal analysis of the frequency of different types of informal votes. More options on a ballot are associated with higher levels of blank, non-sequential and incomplete informal votes and voters in areas with higher levels of education are less likely to unintentionally vote informally.

These findings are robust across model specifications and subgroups within the data. The findings suggest that the decision not to vote is more related to the costs of voting (understanding and deciding on a ranking of the candidates) rather than the potential benefits of an individual's vote being pivotal to the outcome of the election.

This paper is structured so that Section 1.1 gives a summary of the Australian electoral sys-

[1] This back of the envelope calculation does not take into account other effects that would likely happen in a real world situation where the number of candidates halved, such as changes in the political positions of the candidates or their electoral strategies. It also does not account for the fact that adding or removing candidates can affect votes directly when the voting rule does not satisfy the independence of irrelevant alternatives axiom, which is true of most commonly used voting rules.

tem. The main point in this background section is that boundary redistributions are made by an independent body and, therefore are exogenous to the political process. Section 1.2 describes the research design in detail, a Difference-In-Differences (DID) approach. Section 1.3 sets out the data sources. Section 1.4 presents the main results of the analysis with a range of robustness checks following in Section 1.5. Finally, Section 1.6 concludes and also provides context for the results by considering how they relate to electoral outcomes.

1.1 Background on elections in Australia

As the research design makes use of many institutional factors related to the Australian electoral system, we first provide an overview of it.

1.1.1 The Australian Electoral System

Australia is a federation of six states and two territories with separate elections for representatives at both the state and national level. National elections – the subject of our study – are elections of the national Parliament occurring roughly every three years. While each state has different rules for its own elections, rules for national elections are consistent across all states in Australia. In recent elections there has been an increasing trend in voters casting ballots that don't count towards the final result (referred to as informal votes and explained further below) (Australian Electoral Commission, 2016b).

The Parliament in Australia is made up of two houses: The House of Representatives (henceforth 'House') and the Senate. The House has 150 members with each member being elected for a term of three years to represent a single geographic area (formally called an 'electoral division' but also referred to as an 'electorate' or 'seat'). Each electorate has a population of around 100,000 voters. The Senate has 76 senators and each state in Australia has 12 senators to represent it, while each territory has 2 senators to represent it. Each senator serves for a term of 6 years so that, at each election, half of the senate is contested. Thus, every electorate has different candidates for the House while candidates for the Senate are the same for all electorates within a state or territory.

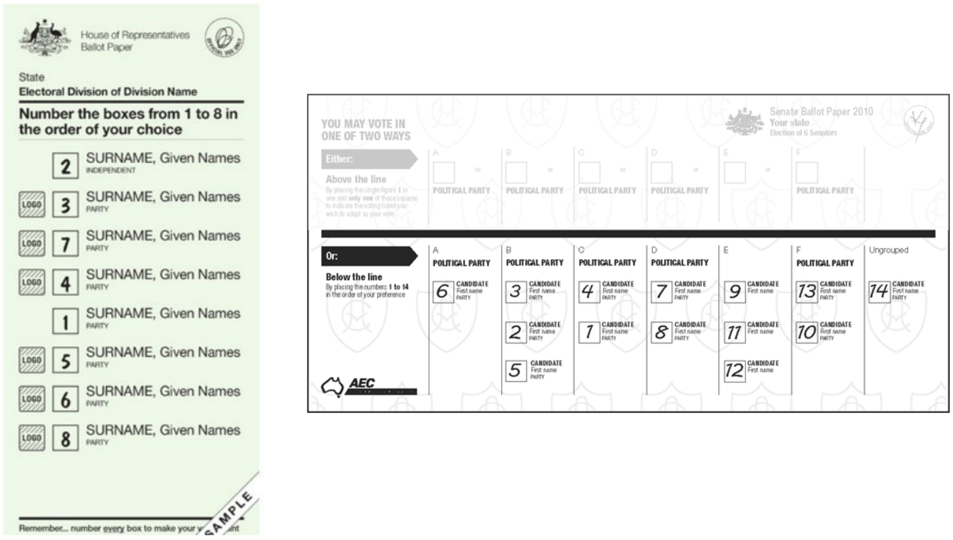


Figure 1.1: Correctly completed House (Left) and Senate (Right) ballots

Note: The Senate ballot is completed 'below the line' and according to the rules for voting in the Senate introduced in 2016, where below the line rankings do not need to be exhaustive.
Source: Australian Electoral Commission (2016c)

Voting for the House and the Senate normally occurs at the same time and location. Voters arrive at a Polling Place in their local electorate, have their name marked off the electoral roll, and are issued two voting papers (ballots): one for the House and one for the Senate. The voter fills out the two ballots and then submits both at the same time.

On both ballots, the voter must list their preferences over the available candidates. Examples of correctly filled out ballots for the House and Senate are provided in Figure 1.1. The candidates in each electorate are officially announced around 3-4 weeks before the election day[2] and the order of candidates on the ballot is randomized at the electorate level.

In the House, the winner in each electorate is selected through a process known as full-preferential preference voting or Instant Run Off voting. In this process, the voter ranks all the candidates in order of preference. Ballots are initially counted for each voter's first preference and then the candidate with the lowest share of first preferences is eliminated with votes redistributed according to the second preference on the ballot. This process continues until one candidate is the remaining choice of a majority of the voters. In the Senate, each state's representatives are selected using a single transferable vote system of proportional representation. In this sys-

[2] For example, in 2016, this announcement was 22 days before the election

tem, votes are counted in a similar way to the House, but, as each state has multiple Senators, a Senator is elected once they receive a certain proportion of the overall vote (14.3% for states and 33% for territories) rather than a majority.

In the Senate, until 2016, a voter could vote 'above the line', where they would number a single box associated with a party (and have their preferences distributed according to the preferences of that party) or they could vote 'below the line', where they would need to rank all candidates on the ballot. In 2016, an adjustment was introduced requiring numbering of at least 6 parties 'above the line' and allow ranking of at least 12 candidates below the line. Figure 1.1 shows a ballot for the Senate in 2016 that is correctly filled out 'below the line'.

Voting in Australia is compulsory. Every Australian citizen who has reached 18 years of age is required to be listed on the electoral roll and to vote in both state and national elections. Enrolment rates are high by international standards with over 96% of eligible Australians enrolled to vote (Australian Electoral Commission, 2019). The accuracy of enrolment is enhanced by data sharing between government agencies and the AEC can directly enrol voters and update their details where sufficient information is available from other government agencies. This is known as the Federal Direct Enrolment and Update (FDEU) program, which uses information from state and territory driver's licences, the Department of Human Services and the Australian Tax Office Australian Electoral Commission (2019). Further, a voter cannot de-register themselves from the voting role with the exception of medical circumstances or permanent international relocation.[3]

Failure to vote at a federal election without a valid and sufficient reason is an offence under section 245 of the *Commonwealth Electoral Act 1918*, which initially carries a $20 penalty. The penalty is first issued by the AEC in a letter to the voter. The letter requires the voter to either pay the penalty or provide a valid and sufficient reason for not voting. Acceptable reasons include situations such as sickness, physical obstruction, natural disasters, personal accident, and urgent public duty but do not include situations such as dislike of candidates or lack of preference over candidates. If the non-voter does not pay the initial $20 fine or pro-

[3] Prisoners are required to be registered and to vote.

vide a valid and sufficient reason for not voting then the AEC may prosecute the non-voter in court and seek a penalty up to the current maximum of $210 plus legal costs. Then, if the non-voter decides not to pay the court fine, the court may impose penalties such as community service orders, seizure of goods, or jail.

In addition to voting in person at the local polling place on election day, referred to as an ordinary vote, there are other options available. Voters can cast their vote at selected polling places within their electorate prior to election day, called pre-poll voting. A voter can also cast an absent vote, where they vote outside their own electorate but are provided with a ballot for their home electorate. Voters can also apply to make a postal vote where the ballots are mailed to the voter's home, the voter completes the ballots in the presence of a witness, and returns them via mail. Overseas voters can vote at the Australian consulate or via post. Both pre-poll and postal voting have been trending up over time with postal voting increasing from around 5.0% in 2014 to around 8.5% in 2010. Pre-poll voting was only introduced in 2010 but has increased from around 7% of votes in 2010 to just under 20% in 2016 (Muller, n.d.). For federal elections, there is not any widespread availability of phone or internet based voting (Lundie, n.d.).

As a result of compulsory voting, the enforcement mechanisms described above and flexible approaches to voting (such as postal votes and pre-polling), turnout is relatively high in Australia -– around 91% in 2016 – although there has been a decline from an average of around 95% in the 1980s and 1990s (Australian Electoral Commission, 2017). There is also a strong relationship between informal voting and turnout in Australia, shown in Figure 1.2. Figure 1.2 uses data at the electorate level for the years 2004-2016 where Non-Vote is the percentage of enrolled voters that do not turnout to vote. The relationship between informal voting and non-voting is positive and statistically significant at conventional levels, and this remains true in unreported regressions that include fixed effects for year and electorate, suggesting that there may be consistent factors which affect both decisions.

Despite voting being compulsory, a voter can submit an empty ballot or a defaced ballot rather than a legitimate vote. This type of vote is recorded in the voting data as an 'informal'

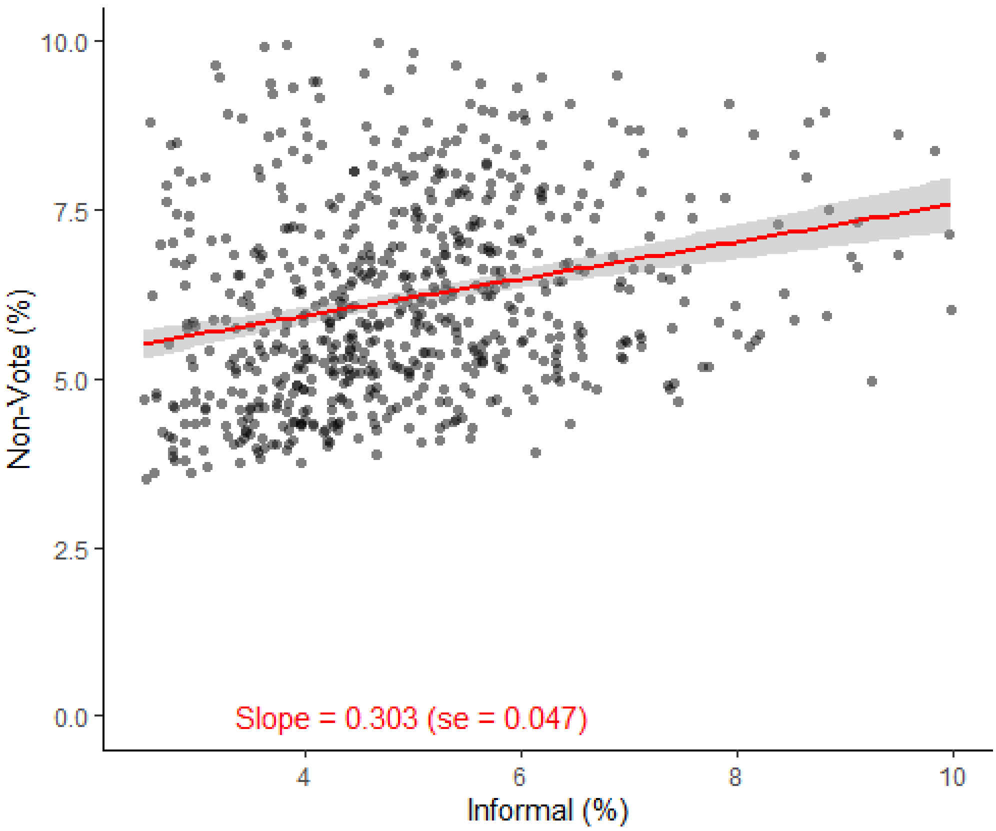


Figure 1.2: Relationship Between Informal Voting and Turnout

Note: Data is at the electorate level covering the years 2004-2016. Non-Vote is defined as 100 minus the turnout percentage recorded the Australian Electoral Commission. The coefficient of the slope remains statistically significant at the 5% level of significance when including fixed effects for year and electorate.
Source: Authors' calculations based on multiple data sources from the Australian Electoral Commission

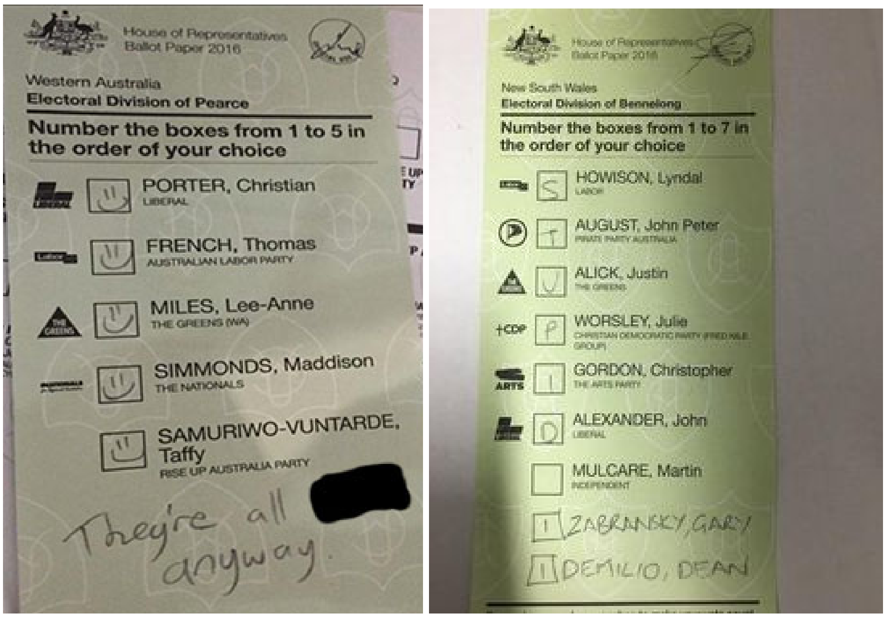


Figure 1.3: Examples of informal votes

Source: Google Images

vote. Examples of informal votes are provided in Figure 1.3. Informal voting can also occur due to misunderstanding the voting rules or a mistake when filling in the ballot (for example, marking two candidates as the first preference).

In recent elections, the rate of informal voting has been around 5-6% in the House and around 3-4% in the Senate. The lower rates of informal voting in the Senate likely reflect that voters have the simpler option of voting 'above the line', as discussed above. Informal votes can be broadly split between intentionally informal votes and unintentionally informal votes. While data on intentionality isn't systematically gathered or available at a Polling Place level, a recent review at the national level reveals that around 60% of informal votes in the House could be classed as unintentional while around 40% could be classed as intentional, with intentional informal votes trending upwards over time. This data is summarized in Table 1.1.[4] Overall, the most common type of informal voting is where a voter only numbers one candidate on the ballot, accounting for an average of 28% of informal votes. The next most common type of informal vote, averaging 23.6% of informal votes, is a blank ballot. Table 1.2 shows data for 2007-2013 – the period over which detailed and comparable data is publicly available.

[4] In this review, unintentional informal votes are defined as ballots with incomplete numbering, non-sequential numbering, ticks and crosses, and ballots in which the voter is identified; all other informal votes are classified as intentionally informal (Australian Electoral Commission, 2016a)

Table 1.1: Unintentional and Intentional Informal Votes in The House Of Representatives 2001-2013

Year	Unintentional	Intentional	Total Informal
2001	3.2%	1.6%	4.8%
2004	3.2%	1.9%	5.1%
2007	2.5%	1.5%	3.9%
2010	2.8%	2.6%	5.5%
2013	3.6%	2.2%	5.8%

Note: In this review, unintentional informal votes are defined as ballots with incomplete numbering, non-sequential numbering, ticks and crosses, and ballots in which the voter is identified; all other informal votes are classified as intentionally informal. Due to a significant methodological change for 2016 the AEC does not recommend comparison of 2016 figures with those of previous years (Australian Electoral Commission, 2016b).
Source: Authors' calculations based on data available in Australian Electoral Commission (2016b).

Table 1.2: Types of Informal Voting at the electorate Level (2007-2013)

	Mean number of votes	Mean share of informal votes (%)
One only	1,321.5	28.1
Blank	1,071.3	23.6
Scribble	696.3	16.1
Non-sequential	611.9	13.9
Non-numeric	528.8	11.3
Incomplete	216.6	4.5
Other	112.0	2.6
Total	4,558.4	100

Note: The results above aggregate categories reported by the AEC. The Non-numeric category aggregates ballots with ticks, crosses and symbols while the Other category aggregates ballots where the voter is identified, where the vote is illegible and the AEC's other category.
Source: Authors' calculations based on data from the Australian Electoral Commission (Australian Electoral Commission (2009), Australian Electoral Commission (2011), Australian Electoral Commission (2016a)

Australia's rate of informal voting is relatively high when compared to other OECD nations. For example, informal votes account for around 0.2% and 0.4% of all votes in the United Kingdom and United States, respectively. Both these countries have first-past-the-post election systems with voluntary voting. Other comparator countries such as Canada (0.7%), New Zealand (1.5%), and Japan (1.7%) are similarly low relative to Australia. Among countries with compulsory voting, rates of informality tend to be higher and more comparable to rates in Australia, with examples being Singapore (2.1%), Argentina (4.13%), Belgium (5.8%), and Brazil (16%) (IDEA, n.d.).

National elections are administered by the Australian Electoral Commission (AEC). The AEC is a federal government agency that oversees organizing, conducting, and supervising federal elections and referendums. The AEC is also responsible for electorate boundaries and redistributions, maintaining the electoral roll, publishing official records of election results, following up on voters who do not vote, monitoring the activities of registered political parties, and distributing public funding of political parties. The existence and role of the AEC is an important piece of the institutional framework for voting in Australia and is critical in the research design of this paper. The structure of the AEC means that many of the administrative aspects of voting are conducted independently of political considerations.

1.1.2 Changing electorate boundaries

The AEC frequently undertakes adjustments of electorate boundaries – referred to as redistributions. For example, in 2000–2017, there were 20 redistributions[5], and at least one redistribution occurred between every election. Redistributions are undertaken to ensure that each state and territory in Australia gains representation in the House in proportion to its population and so that each electorate within a state or territory has similar numbers of voters.

There is a clear and established process for conducting a redistribution. The first step is the establishment of a Redistribution Committee by the AEC for the state or territory where a redistribution has commenced. The committee then calculates the enrolment quota for each

[5] ACT x2, NSW x3, Northern Territory x3, Queensland x3. South Australia x2, Tasmania x2, Victoria x2, Western Australia x3

electorate, which is essentially an estimate of the population divided by the number of seats in the House to which that state is entitled. The committee then divides the state into electorates in order to ensure that the population in each electorate is as close to the enrolment quota as possible. This division process is, legally, required to consider factors such as the economic, social and regional communities of interest, means of communication and travel, the physical features and area, and the existing boundaries. The public can comment on the proposed boundaries, but, once new boundaries have been set, the Parliament has no power to reject or amend the new boundaries. This process is conducted with minimal political input, implying that the redistribution is effectively exogenous to political processes and past political outcomes.

Following completion of each redistribution, the AEC must notify all voters who have been transferred between electorates because of the creation of a new electorate, renaming of an existing electorate, or a change in the boundaries of an existing electorate. Notification is made through all national and state-wide newspapers as well as with letters to all affected voters.

Figure 1.4 shows examples of polling places changing electorates. The main figure highlights the number of polling places nationally that changed electorates between the 2010 and 2013 elections. The insets show a particular instance in western Melbourne where boundaries and polling places were exchanged between two neighboring electorates between the 2010 and 2013 elections. In some cases, as seen in 1.4 a redistribution results in a Polling Place moving from one electorate to another. In this case, the local voters who have changed electorates will continue to vote at the same Polling Place but will now be voting in a different electorate. This means that these voters experience an exogenous change in the number of candidates on the ballot, number of voters in their electorate, and the expected margin. There will, of course, be other factors changing at the same time and so Section 1.2 presents the details of how these other factors will be controlled for.

The approach to redistributions in Australia can be contrasted with gerrymandering of electoral districts in parts of the US, which makes reallocation of a Polling Place an endogenous political decision. The issue of endogeneity of electorate boundaries is given significant con-

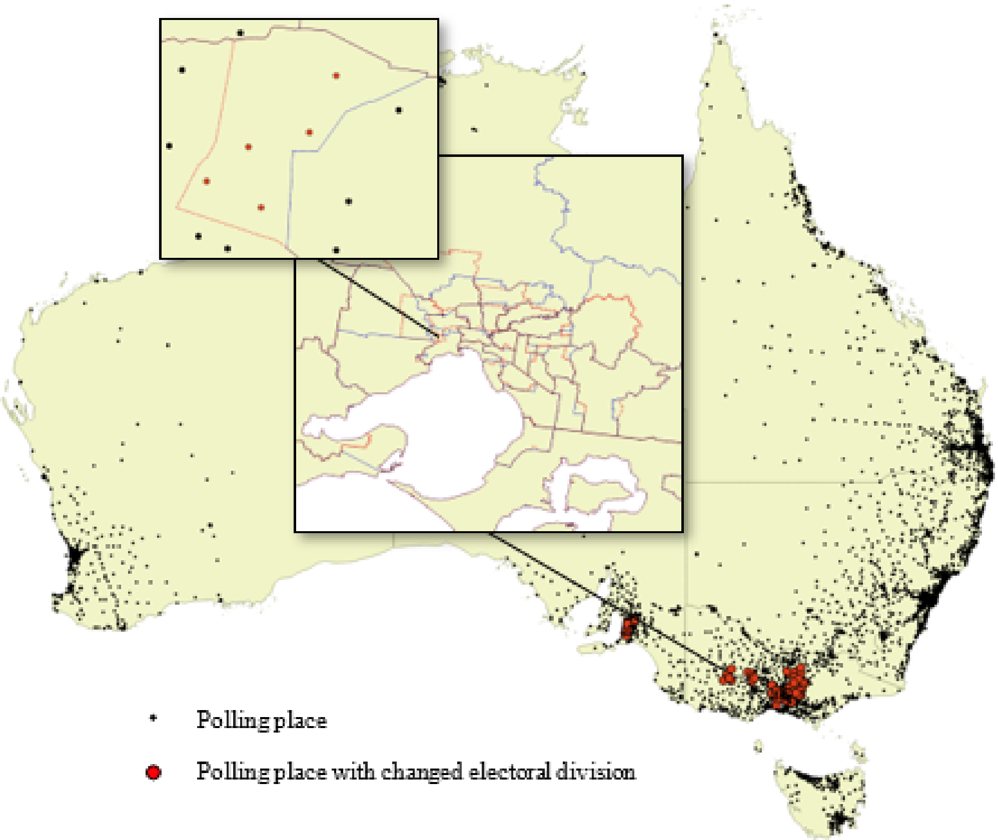


Figure 1.4: Polling Places in Australia with Insets of Boundary Changes

Note: The main map shows polling places which did or did not change electorates between the 2010 and 2013 elections. The insets show the electorate boundaries in western Melbourne for 2010 in solid, blue lines and the boundaries for 2013 in dashed, red lines.
Source: Authors' calculations based on mapping data from Australian Electoral Commission (2018)

Table 1.3: Observed efficiency gap in recent Australian elections

Year	Efficiency Gap
2001	3.8%
2004	3.8%
2007	0.7%
2010	0.2%
2013	5.1%
2016	1.6%

Note: Efficiency Gap is defined as in Stephanopoulos & McGhee (2015), essentially a measure of the difference in the proportion of 'wasted votes' - those which don't help to elect a candidate.
Source: Authors' calculations based on data available on Wikipedia (2018).

sideration by Jones & Walsh (2018), with strong evidence of endogeneity presented in Carson & Crespin (2004). Stephanopoulos & McGhee (2015) propose a relevant statistic, named the efficiency gap, for measuring the degree of gerrymandering. The efficiency gap is a measure of the difference in the proportion of 'wasted votes' between two parties in an election; a wasted vote being defined as the number of votes for the winning party more than 50% plus all votes for the losing party. This statistic allows us to provide evidence for where the Australian system sits in the spectrum from fair to gerrymandered. If information is available on both the vote margin and the final number of seats won by a party, then the approach in Stephanopoulos & McGhee (2015) can be simplified into the formula $e = s - (2 \times v)$ where e is the efficiency gap, s is the seat margin (which is defined as the share of seats won by a party minus 50%), and v is the vote margin (which is defined as the share of votes received by a party minus 50%). In gerrymandered divisions, the efficiency gap will be higher as the goal of gerrymandering is, basically, to waste votes for the opposition party. Applying the simplified efficiency gap formula to the results of recent Australian elections in the House provides the estimated efficiency gaps shown in Table 1.3.

These results indicate that, over this period, elections in the Australian House have seen an average efficiency gap of around 2.3% in favor of the Liberal National Coalition. To put this result into context, Jackman (2015) estimates that Wisconsin, a state where gerrymandering is suspected, recorded efficiency gaps of between 10% and 13% in favor of the Republican party in recent years.

1.2 Research design and econometric specification

We test three hypotheses drawn from the literature:

- **H1:** when the expected margin in an election is higher, informal voting will be higher;
- **H2:** when there are more voters in an electorate, informal voting will be higher; and
- **H3:** when there are more candidates on the ballot, informal voting will be higher.

The margin is a standard indicator of the closeness of an election and is defined as the winning party's vote share minus 50%. In the Australian context, where instant runoff voting is used, the margin refers to the final round of voting that results in the selection of a winning candidate. We also considered an approach to defining the margin based on first preferences, rather than final shares. This alternative definition does not materially alter the results in this paper and also lacks theoretical justification as margin based on first preferences does not directly determine the probability of being the pivotal voter in an election. As a result, the remainder of this paper focuses on the standard definition of the margin with first preferences treated in a robustness check in Section 1.5.

Raw correlations in the data support the three relationships hypothesized. Figure 1.5 shows binned scatter-plots of informal voting percentages in the House at each polling place against the margin, the electorate size, and the number of options on the ballot. All three panels show positive, statistically significant relationships (slopes and standard errors are reported in brackets at the top of the chart).

The relationship seen for Margin is statistically significant, but its size does not appear to be practically meaningful with the estimated effect on informality being only 0.4 percentage points when moving from 0% margin to 25% margin. A similar weak relationship is reported by Kawai et al. (2020).

The positive, statistically significant relationships in Figure 1.5, however, do not imply causal relationships. Consider the following simple linear model:

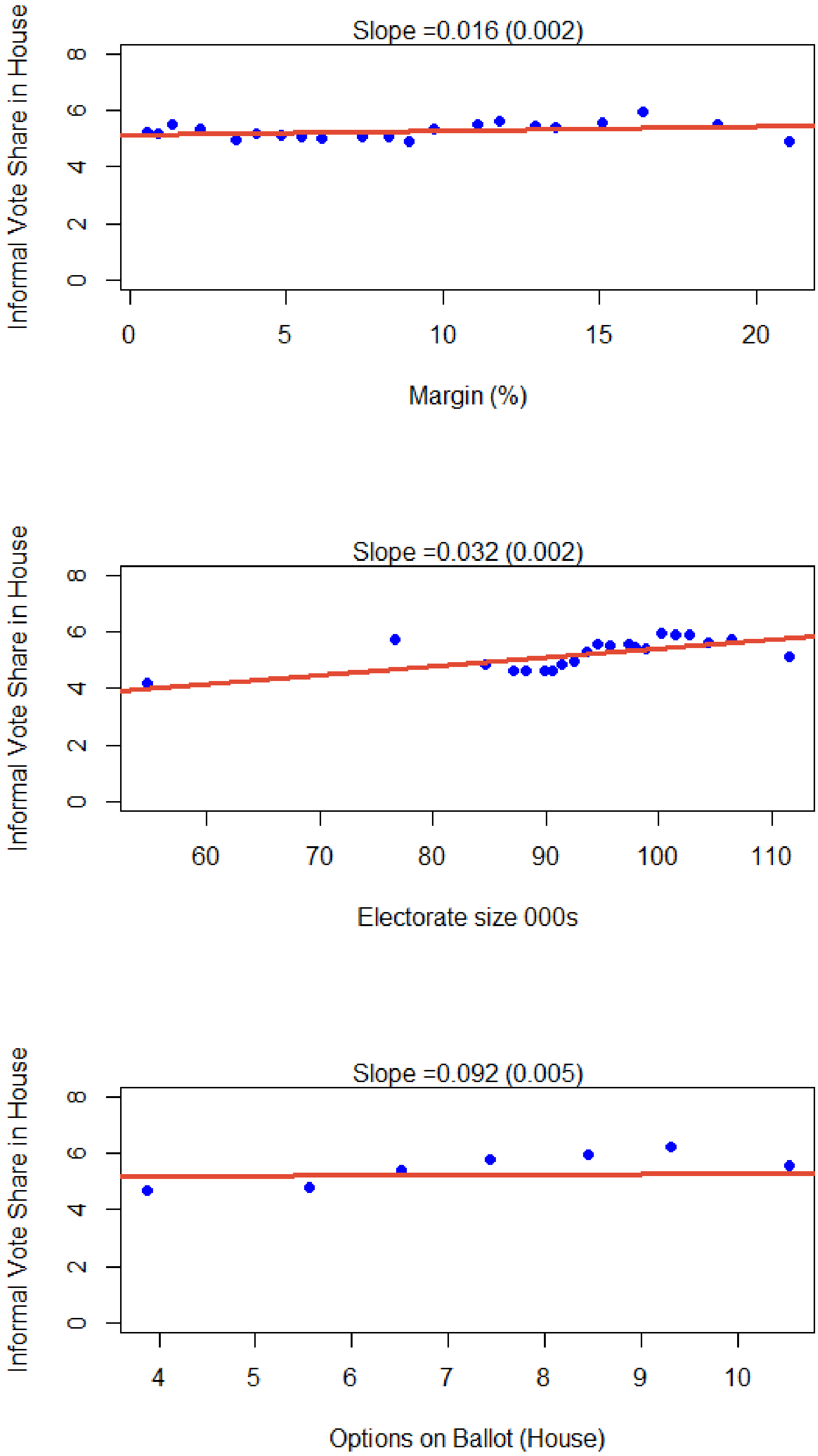


Figure 1.5: Positive relationship between Margin, Electorate Size and Options on Ballot with Informal Voting

Note: Dots represent binned averages where each dot has the same number of observations. The fitted line is derived from an unweighted OLS regression of the form $Informal\% = \beta_0 + \beta_1 Margin + \varepsilon$ with the slope and standard error listed at the top of the figure.
Source: Authors' calculations based on data from Australian Electoral Commission (n.d.)

$$Informal_{i,t} = \theta_1 Margin_{it} + \theta_2 ln(Voters)_{it} + \theta_3 ln(N.Options)_{it} + \mathbf{X}_{it}\beta + \varepsilon_{it}, \quad (1.1)$$

where $Informal_{it}$ is the percentage of informal votes in the House (ranging from 0 to 100) recorded at polling place i in year t. $Margin_{it}$, $ln(Voters)_{it}$, and $ln(N.Options)_{it}$ are the margin (ranging from 0 to 1), the natural log of the number of voters, and the natural log of the number of candidates on the ballot at polling place i in year t, respectively. These particular scales and transformations have been selected in order to give the parameters a comparable and meaningful interpretation. X_{it} is a vector of covariates such as demographic characteristics, and ε_{it} denotes the error term. We assume that errors can be correlated over time within a polling place, addressed through the use of clustered standard errors (Bertrand et al., 2004).[6]

The parameter estimates for θ_1, θ_2, and θ_3 from running this regression model will not necessarily yield causal effects due to endogeneity problems present in the relationship. There is likely to be omitted variable bias, such as knowledge of and interest in politics, which systematically vary across electorates. Also, electorates with small numbers of voters are likely to be in rural areas, leading to systematic differences in informal voting due to unobservable characteristics that aren't captured in $\mathbf{X}$. The voting behavior of an electorate can also affect which candidates are available in that electorate and so can influence the margin.

These endogeneity issues have been widely acknowledged in existing studies. For example, Carson & Crespin (2004), Cox & Katz (2002) and Jones & Walsh (2018) discuss similar identification issues. To address endogeneity issue changes in electorate boundaries have been used; see Ansolabehere et al. (2000), Desposato & Petrocik (2003), Fraga (2016), and Jones & Walsh (2018). A potential concern with applications of this approach to US data is raised by Carson & Crespin (2004) who provide evidence that the method of deciding electorate boundaries in the US affects competitiveness of elections even when courts and administrative organizations set the boundaries. This result is further reinforced by Henderson et al. (2016)

[6] The clustered standard errors in this paper are calculated using the LFE package in R. The clustered standard errors produced by LFE tend to be slightly larger than those produced by STATA.

who show that electorate boundary changes appear to be endogenous political decisions in a number of US jurisdictions.

Our causal inference relies on the exogeneity of boundary changes, and we argue this is a reasonable assumption in the Australian context. Australia has a clear and established administrative process for conducting a redistribution. To corroborate our exogeneity assumption, we conduct an efficiency gap analysis, quantitatively comparing redistributions in the US and Australia (see Section 1.1.2 for details). The results show that the assumption is plausible in Australia.

In this research design, treated polling places are those that changed electorates while the control group are polling places that did not change electorate.[7] A potential concern is that, while votes are counted toward the voter's electorate regardless of where they vote, voters are allowed to vote at any polling place including polling places outside of their electorate. Because we use polling-place level data, our identification strategy relies on the assumption that voters do not systematically change their choice of polling place in response to a redistribution. We argue this is a reasonable assumption because polling places are located at nearby schools or other public venues and rarely move physically. Another concern is that control polling places may experience some form of treatment as the boundaries of their electorate do change. This concern is partially addressed by the fact that the level of change experienced by these control polling places is much smaller than that experienced by the treated polling places. Further, additional analysis will be undertaken to test whether the results are sensitive to inclusion or exclusions of these control polling places.

A simple DID model that exploits the exogenous boundary change is:

$$Informal_{it} = \mu Changed.Division + \gamma_t + \alpha_i + \mathbf{X}_{it}\beta + \varepsilon_{it}, \tag{1.2}$$

[7] As a practical example, the Polling Place located at the Panania Senior Citizens Centre in south Sydney has moved between the electorates of Banks and Hughes several times. In the 2007 election, the Polling Place was in Banks but by 2010 the Polling Place was in Hughes (due to a redistribution in 2009). Then, following another redistribution in 2016, the Polling Place was back in Banks for the 2016 election. The nearby Polling Place at the Lugarno Public School remained in the electorate of Banks throughout all these elections and so could form part of the control group for the Polling Place located at the Panania Senior Citizens Centre. Comparisons like this between inform the research design.

where $Changed.Division_{it}$ is a dummy variable indicating whether Polling Place i changed electorate in year t since the previous election. This DID analysis is motivated by findings from Hayes & McKee (2009) that, after redistricting, voters are 3-7% more likely to suffer roll-off, where voters don't fully complete their ballot, in redistricted areas when compared to voters that were not affected by redistricting. For fixed effects, γ_t denotes a time fixed effects while α_i are polling place fixed effects. Unobserved time-invariant factors could include unobserved socioeconomic characteristics while time fixed effects could include the national political situation or secular changes in the number of candidates who appear on ballots over time. The DID estimator, μ, identifies the causal effect of an electorate change on $Informal_{it}$ under the common trends assumption – the occurrence of an electorate change is orthogonal to the over-time change of ε_{it} conditional on $\mathbf{X}_{it}$.

Our main interest is not the effect of division change but the effects of the margin, the number of voters, and the number of candidates on the ballot. To achieve causal inference, we exploit changes in these three treatment variables that are exogenous due to the electorate change. Combining Equations (1.1) and (1.2) leads to our baseline DID regression:

$$\begin{aligned} Informal_{i,t} = {} & \theta_1^0 Margin_{it}^0 + \theta_2^0 ln(Voters)_{it}^0 + \theta_3^0 ln(N.Options)_{it}^0 \\ & + \delta_1 Change.in.Margin_{it} + \delta_2 Change.in.ln(Voters)_{it} \\ & + \delta_3 Change.in.ln(N.Options)_{it} + \delta_4 Changed.Division_{it} \\ & + \gamma_t + \alpha_i + X_{it}\beta + \varepsilon_{it}, \end{aligned} \tag{1.3}$$

where $Margin_{it}^0$, $ln(Voters)_{it}^0$, and $ln(N.Options)_{it}^0$ are the margin, the natural log of the number of voters, and the natural log of the number of candidates on the ballot in the original electorate of polling place i in year t, respectively. $Change.in.Margin_{it}$ is implicitly defined as $Margin_{it}^0 + Change.in.Margin_{it} = Margin_{it}$ (for polling places in the control group, $Margin_{it}^0 = Margin_{it}$). $Change.in.Margin_{it}$ indicates the change in margin caused by moving between electorates for polling place i in year t. Similarly, $Change.in.ln(Voters)_{it}$ and

$Change.in.ln(N.Options)_{it}$ are the change in the natural log of the number of voters in the electorate and the change in the natural log of the number of options on the ballot caused by moving between electorates for polling place i in year t, respectively. δ_1, δ_2, and δ_3 yield the causal effect of changes in the margin, the number of voters, and the number of candidates on the ballot, under the assumption that the characteristics of the destination electorate are exogenous. δ_4 captures the causal effect of the division change per se, not including the effects of the margin, the number of voters, and the number of candidates.[8]

The timing assumed in (1.3) requires care when interpreting the results. $Change.in.Margin_{it}$, $Change.in.ln(Voters)_{it,}$ and $Change.in.ln(N.Options)_{it}$ could affect voting behavior either immediately or with a lag. It has become common in the relevant literature to test the relationship between margin and a voting outcome during the same time period. This is known as the "ex-post" approach and is based on the proposition that the ex-post outcome of an election is a good proxy for voters' ex-ante beliefs as voters are forward looking and react rationally to information such as polling data (see Geys (2006) for further information). In general, in applications without a clear source of exogenous variation, the ex-post approach poses some endogeneity concerns, but these concerns are avoided due to the proposed research design which makes use of variation in the variables of interest that is exogenous to past or future election outcomes.[9] Frequently, betting market data is used to anticipate the likely margin in an election. However, it was not possible to source data on historical betting odds for elections at the electorate level in Australia with the only historical data available being for which party will form government.

In addition to the specification described above, we also estimate other specifications of the DID as robustness checks. These include additional variables showing the exogenous change in the tenure of the incumbent candidate and the exogenous change in the share of votes for progressive parties.

[8] The treatments (change in number of options, change in electorate size, and change in margin) are continuous variables, i.e. some polling places will move to an electorate with a higher margin while other polling places will move to an electorate with a lower margin. On average, the change in margin for the treatment group could be roughly zero. To account for this, Angrist & Pischke (2008) suggest a model specification that is based on Card (1992) and is similar to the one proposed here.

[9] The "ex-ante" approach was also tested in unreported analysis available from the author on request.

The structure of the Australian electoral system also provides another potential set of controls for the treated polling places that change electorates. Australian elections require voters to submit ballots for both the House and the Senate at the same time. In the House voters are voting as part of their local electorate. This means that the number of options, electorate size, and expected margin varies between each electorate. In contrast, in the Senate, voters are voting as part of their state. This means that, within a state, every electorate has the same number of candidates, number of voters, and expected margin. Since redistributions don't create changes in the Senate, voting in the Senate can therefore form another control with the treatment group being voting in the House.

Comparing the strengths and weaknesses of these two potential control groups, voting behavior in the House in similar Polling Places is likely to provide a better control group than voting behavior in the Senate. This is because there are significant differences between voting and electoral procedures in the House and the Senate. For this analysis, the most important difference is that, in the House, for a vote to be counted as formal, voters must completely rank all candidates available on the ballot, while, in the Senate, a voter can vote 'above the line' and not rank all options available. This can make voting in the Senate less costly in terms of time, research and decision-making effort than voting in the House. As a result, informal voting tends to be systematically higher in the House than the Senate. For this reason, while results for both approaches are reported, nearby or similar Polling Places are our preferred control group, while voting in the Senate acts as an additional robustness check.

For the remainder of this paper, the approach that uses voting in the House and compares polling places that changed electorates with those that didn't is referred to as the DID, this is our preferred specification. The approach where voting in the House and Senate are compared for polling places that changed electorate is referred to as House-Senate-DID (HS-DID).

The approach for HS-DID is very similar and involves variations on:

$$\begin{aligned} Informal_{ijt} &= \theta_1^0 Margin_{ijt}^0 + \theta_2^0 ln(Voters)_{ijt}^0 + \theta_3^0 ln(N.Options)_{ijt}^0 \\ &+\delta_1 Change.in.Margin_{ijt} + \delta_2 Change.in.ln(Voters)_{ijt} \\ &+\delta_3 Change.in.ln(N.Options)_{ijt} + \delta_4 Changed.Division_{it} \\ &+\phi_{it} + X_{it}\beta + \eta House_{ijt} + \varepsilon_{ijt}. \end{aligned} \tag{1.4}$$

For HS-DID, the sample is restricted to polling places that moved between electorates and includes both houses of Parliament (so that j can take a value of either House or Senate). The difference between the two Houses is controlled for using a dummy variable $House_{ijt}$, which takes a value of 1 if the observation is for the House and 0 otherwise. Further, this specification excludes the *Changed.Division* variable as all observations in this specification have changed division. The other major change is that the fixed effects, $\phi_{i,t}$, have been implemented as an interaction of polling place and time. This is because, in 2013, all the treated polling places only received treatment in that year -– which creates perfect multicollinearity between time period and polling place fixed effects for 2013.

The presence of the two alternative control groups and the two DID formulations allows for the application of a triple differences approach (DDD):

$$\begin{aligned} Informal_{ijt} &= \theta_1^0 Margin_{ijt}^0 + \theta_2^0 ln(Voters)_{ijt}^0 + \theta_3^0 ln(N.Options)_{ijt}^0 \\ &+\delta_1 Change.in.Margin_{ijt} + \delta_2 Change.in.ln(Voters)_{ijt} \\ &+\delta_3 Change.in.ln(N.Options)_{ijt} + \delta_4 Changed.Division_{it} \\ &+\gamma_t + \alpha_i + X_{it}\beta + \eta House_{ijt} + \varepsilon_{ijt}. \end{aligned} \tag{1.5}$$

The DDD model is then estimated using both Houses of Parliament and Polling Places that both moved and did not move between electorates.

1.3 Data

The primary data source is the AEC's voting data, "First Preferences by Candidate by Polling Place" for the 2004, 2007, 2010, 2013, and 2016 federal elections. For these elections, the AEC makes Polling Place level data available on its website. Earlier elections only have electorate level data available, making them impractical to use in this research design. The observation level in this data is the (Polling Place, House of Parliament) pair with a count of first preference votes given for each candidate including a count of informal votes. The AEC data also provides the number of voters, and the number of options on the ballot in each electorate. Data was also gathered from the Australian Broadcasting Corporation (ABC) on the incumbent party in each electorate, the winning party, and the margin for the winning party in each election.

There are currently around 8,300 Polling Places in Australia in total, but this varies between elections. A number of restrictions are placed on the Polling Places that are included in the analysis. First, we only include Polling Places that are present in each election from 2004 to 2016. This reduces the number of Polling Places included to 6,360 across 150 electorates. The remaining data is referred to as 'All Data' in the following summary tables.

We then impose restrictions to select the sample for our analysis. First, electorates which were created, nullified, or renamed are excluded.[10] This ensures that a change in the electorate name of a Polling Place was genuinely associated with a change in electorate boundaries and not a result of other administrative changes. This results in a final set of around 6,000 Polling Places in each election across 143 electorates, this is a reduction of approximately 5.2% of the data.

Next, we exclude observations with missing values for the variables of interest (margin, number of voters, and options) as well as any missing values for relevant socio-economic covariates,

[10]Electorates are not often created, destroyed or renamed (of the 65 electorates included in the 1901 election, 34 are still in existence). For example, the electorate of Charlton, located north of Sydney in the Hunter region of NSW, was eliminated prior to the 2013 election. The electorate of Burt, located in the South-Western suburbs of Perth in Western Australia, was created for the 2013 election –- reflecting relative population growth of Western Australia to the rest of Australia. Three electorates were renamed over the period from 2001.

an additional 3.4% of observations. Lastly, we exclude polling place observations that, after applying the above restrictions, appear only once during the study period of 2007–2016, an additional 0.8% of the data. Note that data for 2004 is used only to determine whether a polling place changed electorates for the 2007 election. This results in a final set of data that contain 23,096 polling place-year observations for 4 elections across 143 electorates for the House of Representatives. With the Senate included, this creates 46,192 observations at the polling place–House of Parliament–year level as each polling place generates an observation for the House and the Senate in each year.

The data remaining after these exclusions is referred to as 'DID Data' in the following summary tables. A summary of these Polling Places is set out in the table below. We identify polling places that move between electorates using name changes in successive elections. In general, around 2-8% of Polling Places are identified as having changed electorate in any given election. For 2013, there are fewer Polling Places that changed electorate because, between 2010 and 2013, only relatively minor redistributions occurred, and these were limited to Victoria and South Australia.

Table 1.4: Number of Polling Places and electorates in the Sample

	2004	2007	2010	2013	2016
Panel A - All Data					
Polling Places	6,360	6,360	6,360	6,360	6,360
Changed electorate	NA	623	661	156	591
Did not change	NA	5,737	5,699	6,204	5,769
electorates	150	150	150	150	150
Panel B - DID Data					
Polling Places		5,731	5,861	5,841	5,663
Changed electorate		418	426	156	415
Did not change		5,313	5,435	5,685	5,248
electorates		143	143	143	143

Note: All Data includes all polling places present in each election. "DID data" includes polling place observations used for DID analysis after sample selection.
Source: Authors' calculations based on data from Australian Electoral Commission (n.d.)

Table 1.5 summarizes other variables constructed from the AEC and ABC data. This data indicates that, in the House, the informal vote share has a mean of 5.3%. In the Senate, the informal vote share has a mean of 3.6%. The data also shows that, although the AEC attempts to keep the population in each electorate roughly equal (at around 100,000), there is still variation. The smallest electorate included 54,725 registered voters while the largest included 143,231. The average electorate contains around 95,195 voters. The number of candidates on the ballot in each polling place for both the House and Senate is also covered. The minimum number of candidates seen in the House is 3, the maximum is 19 with a mean of 7.6. The number of options on Senate ballots ranges from 3 to 65 with a mean of 29.2.[11] For use in additional robustness checks we also calculate the tenure (in years) of the incumbent candidate and the share of votes for progressive parties (defined as first preference votes for the ALP and Green parties). In the DID analysis, we use the number of options, the number of voters, and tenure in log form.

The 'Change in' variables are always zero for polling places in the control group and also for the Senate, as it is only treated polling places and the House that are affected by the change in electorate boundaries. The 'Change in' variables are also close to zero in the All Data and DID Data columns as the treated polling places only make up a small portion of the overall data.

This voting data is then merged with social, demographic and economic information. This supporting data is not available at the Polling Place level. As a result, a GIS program was used to match the latitude and longitude coordinates for Polling Places to their respective Statistical Area Level 2 (SA2) as defined by the Australian Bureau of Statistics (ABS). There are around 2,200 SA2s in Australia with populations in the range of 3,000 - 25,000 and an average population of around 10,000. Each SA2 aims to represent a community that interacts together socially and economically (ABS, 2016a). A single SA2 is likely to contain multiple Polling Places, making this approach unable to provide social, demographic, and economic information at the level of the Polling Place. The SA2 was selected as the most appropriate area for this matching because it presents a reasonable tradeoff between a smaller geographic area that is better matched to a Polling Place and a larger geographic area that has better data available.

[11] There are generally more options on a Senate ballot as each state or territory elects multiple senators by proportional representation, making the Senate a more appealing target for minor party candidates.

Table 1.5: Summary Statistics For Key Variables

	All Data		DID Data		Treated		Control	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
House informal share	5.30	2.61	5.28	2.57	5.97	2.98	5.23	2.54
Senate informal share	3.58	1.86	3.52	1.83	3.97	2.26	3.50	1.79
Margin	0.09	0.06	0.09	0.06	0.09	0.06	0.09	0.06
Voters	95,195	9,939	97,072	9,386	98,081	8,607	97,006	9,431
Number of House Options	7.63	2.76	7.57	2.80	6.83	2.03	7.61	2.83
Number of Senate Options	29.18	10.38	31.22	10.35	30.90	8.20	31.24	10.47
Tenure	9.94	5.88	10.23	6.09	9.23	5.68	10.30	6.11
Progressive vote share	0.51	0.16	0.52	0.16	0.53	0.18	0.52	0.16
ln(Voters)	11.46	0.11	11.48	0.10	11.49	0.09	11.48	0.10
ln(N House Options)	1.97	0.34	1.96	0.35	1.88	0.30	1.97	0.35
ln(N Senate Options)	3.30	0.41	3.38	0.37	3.39	0.28	3.38	0.38
ln(Tenure)	2.06	1.02	2.12	0.68	2.01	0.68	2.12	0.68
Change in Margin	0.000	0.020	0.000	0.020	0.004	0.070	0.000	0.000
Change in ln(Voters)	−0.000	0.01	0.000	0.01	0.001	0.050	0.000	0.000
Change in ln(N House Options)	−0.001	0.070	−0.001	0.08	−0.01	0.310	0.000	0.000
Change in ln(N Senate Options)	0	0	0	0	0	0	0	0
Change in ln(Tenure)	−0.04	0.77	0.000	0.24	0.003	0.970	0	0.000
Change in Progressive vote share	0.005	0.03	0.01	0.03	0.10	0.09	0.00	0.00
Observations		31,800		23,096		1,415		21,681

Note: All Data includes all polling places present in each election. “DID data” includes polling place observations used for DID analysis after sample selection.
Source: Authors’ calculations based on data from Australian Electoral Commission (n.d.) and Australian Broadcasting Corporation (2019)

After mapping Polling Places into SA2s, a range of social, demographic, and economic data from ABS’s National Regional Profile data (ABS, 2016b) is matched to each Polling Place. The National Regional Profiles contain information such as population, median age, median income, population density, percentage of people with a tertiary degree, the unemployment rate, and housing costs. A summary of these demographic and economic characteristics is provided in columns 1-3 of Table 1.6. When used in regressions, data on Population Growth is split into two variables –- one for areas that experienced population growth and one for areas that experienced decline (the absolute value is used in the regression).

Although the change in electorate boundaries is administered in an apolitical way, there is still the possibility that the treatment and control polling places differ in meaningful ways. For example, in a given year, electorate boundaries may change in Victoria and be unchanged in the Northern Territory. Polling places in the Northern Territory may differ systematically in both observable and unobservable characteristics from those in Victoria, presenting less than ideal controls. Two different approaches to address this are used: propensity score matching and distance-based restrictions. It is worth noting that neither of these approaches deals with unobservable characteristics unless they are correlated with observable ones. When neither of these approaches are used, the output tables are called "Standard" outputs.

For the propensity score matching approach, the propensity score is estimated using a range of observable characteristics of the polling place that should not be affected by treatment:

$$
\begin{aligned}
Changed.Division_{it} &= \beta_0 + \beta_1 Median.Age_{it-1} + \beta_2 Average.Income_{it-1} \\
&+\beta_3 Unemployment.Rate_{it-1} + \beta_4 Population.Density_{it-1} \\
&+\beta_5 Population.Growth.Rate_{it-1} + \beta_6 New.House.Value_{it-1} \\
&+\beta_7 ESL_{it-1} + \beta_8 Tertiary.Degree_{it-1} + \varepsilon_{it},
\end{aligned}
\tag{1.6}
$$

where $Changed.Division_{it}$ takes the value of 1 if Polling Place i changed electorate between time period $t-1$ and time period t. Other variables should be self-explanatory with the possible exception of $ESL_{i,t-1}$, which is the percentage of households where English is a second language. The propensity score is estimated using a logit distance function. Matching is done based on the nearest neighbor technique without replacement (Ho et al., 2007). The pre- and post-matching means for both the treated and control groups are presented in Table 1.6. In most cases the treated and control groups are similar in observable characteristics before matching. After matching, the absolute value of the standardized mean difference is less than 0.1 which satisfies the rule of thumb provided in Flury & Riedwyl (1986) for matching to have successfully produced treated and control groups that are similar in observable characteristics.

For distance-based restrictions, the sample is restricted to Polling Places within 2.5 kilometers of treated Polling Places. To the extent that there are characteristics of treated Polling Places that are correlated with their physical location, this geographic restriction should help ensure that the treated and control Polling Places are as similar as possible to each other in terms of observable characteristics. An advantage of the distance-based restrictions over propensity score matching is that distance restriction may provide additional control for time varying unobservable characteristics that are associated with geographic location (such as regional polit-

Table 1.6: Pre and Post matching means for treated and control groups

	Pre Matching			Post Matching		
	All	Treated	Control	Treated	Control	Std. Mean Diff
Median Age	39.63 (5.17)	39.31 (5.42)	39.64 (5.15)	38.45 (5.42)	38.5 (4.58)	-0.01
Mean Income (000)	49.86 (15.58)	48.6 (13.68)	49.93 (15.68)	44.26 (13.68)	44.53 (14.15)	-0.02
Unemployment (%)	5.58 (2.1)	5.81 (2.2)	5.57 (2.09)	5.71 (2.2)	5.6 (2.22)	0.05
Population Density	1,171.14 (1,589.28)	1,097.12 (1,706.6)	1,175.4 (1,582.17)	1,015.68 (1,706.6)	990.6 (1,274.88)	0.02
Population Growth (%)	0.87 (3.36)	0.5 (4.29)	0.89 (3.3)	1.04 (4.29)	1.02 (1.73)	0.01
House Value (000)	452.4 (578.36)	400.62 (414.53)	455.39 (586.27)	332.18 (414.53)	337.75 (327.14)	-0.02
English 2nd Language (%)	14.14 (16.14)	16.64 (20.93)	14 (15.8)	16.04 (20.93)	14.66 (17.13)	0.07
Tertiary Degree (%)	17.23 (10.78)	14.96 (9.49)	17.36 (10.83)	14.42 (9.49)	14.65 (9.19)	-0.03

Note: Matching is done based on the nearest neighbor technique without replacement Ho et al. (2007). Standard errors shown in parenthesis. In all cases, the absolute value of the standardized mean difference is < 0.1 which satisfies the rule of thumb provided in Flury & Riedwyl (1986).

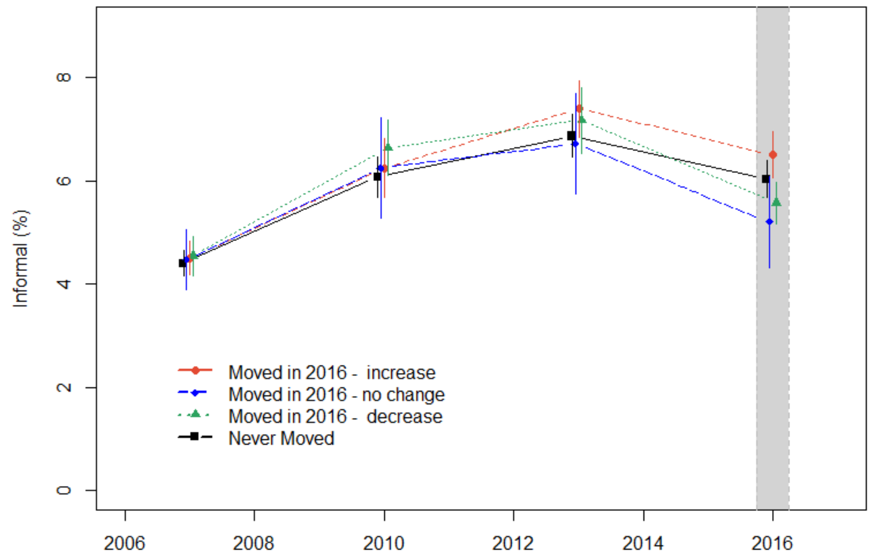


Figure 1.6: Time trends for groups receiving different changes in the number of options on the ballot

Note: Polling places in the 'increase' group experienced an increase in the number of options on the ballot in 2016 – similarly for 'no change' and 'decrease' group. The 'Never Moved' group did not move electorates at any time between 2007 and 2016. The figure also includes 95% confidence intervals around each point. The 'Never Moved' group has been re-weighted using propensity score matching at the polling place level using observable characteristics in 2007, 2010 and 2013.
Source: Authors' calculations based on data from Australian Electoral Commission (n.d.)

ical sentiment), while the propensity score matching approach can only adjust for observable characteristics. However, the distance-based restriction does result in the smallest sample size.

Undertaking matching also allows for a visual test of whether the common trends assumption is met in the data. Figure 1.6 shows the rate of informal voting in the House over time and split into four groups: polling places that never moved; polling places that only moved in 2016 and experienced an increase in the number of options on the ballot; polling places that only moved in 2016 and experienced a decrease in the number of options on the ballot; and polling places that only moved in 2016 but experienced no change in the number of options on the ballot. Figure 1.6 isolates the effect of treatment in 2016 and includes 95% confidence intervals around each point. The observations for the 'Never Moved' group have been re-weighted based on a matching procedure similar to that described above but applied at the polling place level and only to those in the 'Never Moved' group. For this figure, polling places were matched based on observable characteristics in 2007, 2010 and 2013.

Visually, it appears that each group broadly follows the same time trend with observations in 2007, 2010 and 2013, showing substantial overlap in confidence intervals between all four groups. In 2016, the group that recorded an increase in the number of options appears to experience higher levels of informal voting, while those in the no change and decrease groups record relatively lower levels of informal voting. This visual analysis supports the common trends assumption and also indicates some of the main findings in the following section.

1.4 Results

1.4.1 Main results

There are several sets of results presented below, with a range of robustness tests and alternative specifications also shown. Table 3.4 presents the main results, starting with some basic models for comparison, and then focuses on the DID. Column 1 shows the results of a simple linear regression comparable to the relationships that are shown in Figure 1.5. In this simple analysis, the relationships between the number of options, voters and margin are all positive and statistically significant. Column 2 introduces a range of socioeconomic covariates to the simple regression, resulting in a change of sign for the margin covariate, although it is no longer statistically significant at conventional levels. The same general findings carry over into Column 3, where fixed effects for polling place are also included.

Columns 4-6 show the results of the DID, Column 4 uses exogenous changes in the margin, voters and number of options.[12] Column 5 shows the same model after propensity score matching, while Column 6 shows the distance limited results. The results in Columns 5 and 6 should be interpreted as robustness checks.

To confirm the three main hypotheses, the coefficients for *Change in Margin*, *Change in ln(Voters)* and *Change in ln(N Options)* shown in columns 4, 5, and 6 should all be positive and statistically significant. In all cases, the parameter estimate for *Change in ln(N Options)* is statistically significant and positive, which is the sign implied by the hypotheses. Across

[12] The data set is voting in the House of Representatives with treated polling places being those that moved between electorates and control polling places being those that did not move

Table 1.7: Main Results

	Dependent variable: Informal %					
	Model specifications					
	OLS	OLS w. covariates	Fixed Effects	DID Standard	DID Propensity Score Matched	DID Distance Limited
	(1)	(2)	(3)	(4)	(5)	(6)
Margin	2.177^{***}	-0.217	-3.195^{***}	-3.404^{***}	-5.280^{***}	-5.450^{***}
	(0.345)	(0.283)	(0.356)	(0.367)	(0.610)	(0.633)
ln(Voters)	3.534^{***}	1.387^{***}	0.837^{**}	0.975^{***}	3.265^{***}	0.571
	(0.192)	(0.156)	(0.351)	(0.361)	(0.604)	(0.601)
ln(N Options)	0.468^{***}	0.858^{***}	2.079^{***}	2.056^{***}	2.176^{***}	1.744^{***}
	(0.067)	(0.053)	(0.057)	(0.057)	(0.097)	(0.112)
Change in Margin				-2.232^{**}	-3.486^{***}	-3.217^{***}
				(0.891)	(1.042)	(0.915)
Change in ln(Voters)				-0.881	-0.575	-0.161
				(1.107)	(1.362)	(1.161)
Change in ln(N Options)				2.380^{***}	2.508^{***}	2.209^{***}
				(0.205)	(0.263)	(0.209)
Changed Division				-0.298^{***}	-0.446^{***}	-0.215^{***}
				(0.065)	(0.092)	(0.065)
Covariates		✓	✓	✓	✓	✓
Time FE		✓	✓	✓	✓	✓
Polling Place FE			✓	✓	✓	✓
Clusters (Polling Place)	5,930	5,930	5,930	5,930	4,195	1,955
Observations (Polling Place × Year)	23,096	23,096	23,096	23,096	11,677	7,483
Treated Observations	NA	NA	NA	1,415	1,063	1,415
Control Observations	NA	NA	NA	21,681	10,614	6,068
R^2	0.030	0.432	0.354	0.356	0.378	0.413

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Column 1 shows the results of a simple linear regression; Column 2 introduces a range of socioeconomic covariates; Column 3 introduces fixed effects for Polling Place. Columns 4-6 shows the results of the DID. Column 4 presents the main output, which uses voting in the House with treated Polling Places being those that moved between electorates and control Polling Places being those that did not move. Column 5 shows the same model but after propensity score matching to make the observable characteristics of treated and control groups similar has been applied; Column 6 shows results where the sample is limited to Polling Places within 2.5 kilometers of treated Polling Places. R^2 for FE models is the unadjusted 'within' R^2. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

all three models, the parameter estimate for *Change in ln(Voters)* is not statistically significant while the estimate for *Change in Margin* is negative and statistically significant. This is a rejection of H1 and H2, and a confirmation of H3. These results are in line with the literature that focuses on the mental processing costs of voting as well as being somewhat consistent with Feddersen & Pesendorfer (1996), whose model suggests no causal relationship between pivot probabilities and abstention. The negative parameter estimate for Change in Margin could be related to a bandwagon effect where voters seek to support a candidate who is expected to win (Grillo, 2017). Another explanation could be that political parties may be better resourced in seats where they have a large margin. Parties may then engage in more activities such as mail outs, polling place volunteers and how to vote cards, which may work to reduce the rate of informal voting.

The parameter estimate of 2.38 for *Change in ln(N Options)* indicates that, if there was a doubling of the number of options on the ballot, then the level of informal voting will increase by 2.38 percentage points. With an average level of informal voting of around 5.3%, this would be equivalent to a 45% increase in informality. As the number of options tends to be between 4 and 8, changes of 25% to 100% are realistic and this suggests the results are significant in practical terms.

Applying this estimate linearly indicates that, if the number of options were reduced by half in each electorate then the total number of observed informal votes in the data would reduce by 27% and the share of informal votes would fall from 5.4% in total to 3.9%. This back of the envelope calculation does not take into account other effects that would likely happen in a real world situation where the number of candidates halved, such as changes in the political positions of the candidates or their electoral strategies.

The parameter estimate for *Changed Division* is negative and statistically significant across all specifications. This indicates that voters who experience a change in their electorate are less likely to submit an informal vote than those that don't change division. This may be due to voters taking more interest in the 'new' candidates or the issues in their new electorate and engaging more in the political process. This result is the opposite of that reported in Hayes

& McKee (2009), who look at the effect on voter turnout in Texas and find that redistricting reduces turnout. This difference may be because Hayes & McKee (2009) do not use fixed effects to control for unobserved factors and there may be significant endogeneity issues with their research design given the politicized nature of redistricting in Texas.

For all models, the results are presented using clustered standard errors with the cluster being defined at the polling place level (Bertrand et al., 2004). Clustering at the polling place level allows for the errors to be correlated within a polling place. This seems reasonable as voting behavior within a polling place is unlikely to be affected by or influence other polling places but there is likely to be some form of correlation over time within the same polling place.

We also analyzed subgroups within the data. We focused on subgroups defined by the level of margin, the size of electorate, income levels, tertiary education levels and English as a second language levels. Investigation of these subgroups generally produced results similar to those above. We were generally not able to identify specifications or subgroups where the coefficients have the signs implied by H1, H2, and H3 and are statistically significant at conventional levels at the same time.

Table 1.8 shows these results when the data is subset according to quartiles of tertiary education. The mean rate of tertiary education ranges from 7.28% in the lowest quartile to 33.09% in the highest. For the highest education group (Quartile 4), informal votes are less prevalent, the sign for *Change in ln(N Options)* and *Change in Margin* are in line with the implications of the hypotheses and are statistically significant.

These results indicate that, in better-educated areas voters react to the competitiveness of their electorate as predicted by theory. Better educated voters may consider the strategic implications of their voting decisions more closely than other groups. A potential explanation is that those with high education levels may be more engaged in political issues (which may reduce their costs of acquiring information on candidates); may see greater personal benefits from having their preferred candidate elected; may understand how the electoral system works in greater detail; and may be less prone to bandwagon effects. These voters still respond to

Table 1.8: Subgroup analysis based on quartiles of Tertiary education levels

	Dependent variable: Informal %			
	Quartile 1 (lowest)	Quartile 2	Quartile 3	Quartile4 (highest)
Change in Margin	-3.550^{***}	-3.521^{*}	-4.094^{*}	4.040^{**}
	(1.366)	(2.049)	(2.322)	(1.683)
Change in ln(Voters)	-1.661	-2.326	0.755	-1.996
	(2.794)	(2.140)	(2.085)	(1.999)
Change in ln(N Options)	2.605^{***}	1.936^{***}	2.021^{***}	3.198^{***}
	(0.371)	(0.482)	(0.414)	(0.377)
Changed Division	-0.305^{**}	-0.457^{***}	-0.180^{*}	-0.052
	(0.133)	(0.141)	(0.107)	(0.118)
Covariates	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
Polling Place FE	✓	✓	✓	✓
Mean of Informal %	5.66	5.55	5.46	4.44
Mean of Tertiary Degree %	7.28	10.83	16.96	33.09
Observations (Polling Place × Year)	5,894	5,660	5,711	5,767
R^2	0.327	0.375	0.428	0.369

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Quartile 1 represents areas with the lowest percentage of people with tertiary degrees while Quartile 4 represents areas with the highest percentage of people with tertiary degrees. R^2 for FE models is the unadjusted 'within' R^2. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

the number of options in the same way as other voters -– indicating that this result is not explained by differences in education.

The results in Table 1.8 provide mixed support for the implications of Feddersen and Pessendorfer's model of vote abstention, where uninformed voters abstain so that the election can be controlled by informed voters (Feddersen & Pesendorfer, 1996). The general relationship between education and the level of informal voting is as implied by the theory, but the statistically significant parameter estimate for Change in Margin is counter to their theory. This suggests that the literature that focuses on the mental processing costs associated with correctly completing a ballot may provide the best explanation for the behavior seen here.

1.4.2 Robustness checks

Table 1.9, expands the main results by including the HS-DID and DDD approaches. In this table, Panel A shows the the DID results, Panel B shows the HS-DID results and Panel C shows the DDD results. Within each of these panels, Column 1 presents the standard results, Column 2 presents the propensity score matched results and Column 3 presents the distance limited results. This aligns with Columns 4, 5 and 6 of the main results table. The alternative approaches do not affect HS-DID, thus only a single set of results is presented in Panel B. Across all models and data restrictions, the parameter estimates for *Change in ln(N Options)* is positive and statistically significant. Further, the parameter estimates for *Change in ln(Voters)* is generally not statistically significant and the estimate for *Change in Margin* is negative and statistically significant. Again, this is a rejection of H1 and H2, and a confirmation of H3.

Turning to Columns 4 and 5 of Table 1.9, a potential alternative approach is to change or restrict the definition of the control group. In the results above, treated Polling Places are those that changed electorate while the control group are Polling Places that did not change electorate. In this control group, there are Polling Places located in electorates that have a boundary change. An argument could be made that these control Polling Places do experience some form of treatment, although not as extreme as Polling Places that change electorates. To address this issue, Column 4, in the results below, removes these Polling Places from the control group. That is, in Column 4, the control group is made up of only Polling Places that are located in electorates that did not experience any boundary change for that year. In contrast, Column 5 restricts the control group to be only Polling Places in electorates that had boundary changes. Although these two approaches use disjoint control groups, they provide results that are very similar in nature to those seen in the main results. Propensity score matching is not used in Column 3-5 of Table 1.9.

Table 1.9: Alternative model specifications and control groups

	Dependent variable: Informal %				
	Standard	Propensity Score Matched	Distance Limited	Controls are non-treated divisions	Treated Divisions only
	(1)	(2)	(3)	(4)	(5)
Panel A - DID (House, treated and control Polling Places)					
Change in Margin	-2.232^{**}	-3.486^{***}	-3.217^{***}	-1.784^{*}	-4.815^{***}
	(0.891)	(1.042)	(0.915)	(0.985)	(1.219)
Change in ln(Voters)	-0.881	-0.575	-0.161	-0.714	-5.576^{***}
	(1.107)	(1.362)	(1.161)	(1.240)	(1.826)
Change in ln(N Options)	2.380^{***}	2.508^{***}	2.209^{***}	2.478^{***}	2.121^{***}
	(0.205)	(0.263)	(0.209)	(0.228)	(0.283)
Changed Division	-0.298^{***}	-0.446^{***}	-0.215^{***}	-0.459^{***}	-0.026
	(0.065)	(0.092)	(0.065)	(0.075)	(0.110)
Observations (Polling Place × Year)	23,096	11,677	7,483	15,534	6,130
R^2	0.356	0.378	0.413	0.394	0.383
Panel B - DID (House and Senate, treated Polling Places only)					
Change in Margin			1.045		
			(0.947)		
Change in ln(Voters)			0.098		
			(1.253)		
Change in ln(N Options)			1.709^{***}		
			(0.218)		
Observations (Polling Place × Year × House)			2,830		
R^2			0.356		
Panel C - DDD (House and Senate, treated and control Polling Places)					
Change in Margin	-0.057	-0.736	-0.969	0.457	-1.404
	(0.741)	(0.814)	(0.734)	(0.751)	(0.943)
Change in ln(Voters)	-0.062	0.724	0.373	0.141	-2.011
	(0.888)	(1.014)	(0.910)	(0.921)	(1.290)
Change in ln(N Options)	1.922^{***}	1.955^{***}	1.836^{***}	1.950^{***}	1.811^{***}
	(0.182)	(0.202)	(0.176)	(0.182)	(0.220)
Changed Division	-0.136^{***}	-0.220^{***}	-0.090^{**}	-0.219^{***}	-0.043
	(0.043)	(0.057)	(0.043)	(0.046)	(0.068)
Observations (Polling Place × Year × House)	46,192	23,343	14,966	31,068	12,260
R^2	0.412	0.427	0.466	0.396	0.551

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Models include covariates and Polling Place fixed effects. Panel A shows the DID results, Panel B shows the HS-DID results and Panel C shows the DDD results. Time period fixed effects are included for models in Panel A and Panel C. Models shown in Panel B produce the same results across all specifications and do not include a Changed Division variable. Column 1 presents the standard results, Column 2 presents the propensity score matched results and Column 3 presents the distance limited results. In Column 4, the control group is made up of only Polling Places in electorates that did not experience a boundary change. In Column 5, the control group is restricted to be only Polling Places in electorates that had boundary changes. Propensity score matching is not applied to columns 1, 3, 4 or 5. R^2 for FE models is the unadjusted 'within' R^2. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 1.10 presents the results of a placebo test where the dependent variable is changed to variables where a genuine treatment effect is not expected, both standard and propensity score matched results are included. The variables that have been selected are related to the election process but should not, theoretically, be affected by the number of options available on the ballot, the number of voters in the electorate or the margin in the electorate. Column 1 and Column 2 report the results of a model where the dependent variables are the total number of votes recorded in the House and Senate respectively. Due to compulsory voting in Australia, this shouldn't be directly affected by political conditions. Columns 3, 4, and 5 focus on outcomes in the Senate. Column 3 focuses on the percent of informal votes in the Senate and Column 4 focuses on the percent of Donkey votes in the Senate, while Column 5 looks at the share of votes for non-major parties (i.e., not Liberal, National, Labor or the Greens). In this case, Donkey voting is defined as when a voter votes for the first party on the ballot as their first preference. Each of these outcomes should not be affected by changes in the number of options, voters or margin in the House.

The treatment is not found to be statistically significant at conventional levels in 33 of the 40 parameters. A statistically significant result is found for the relationship between change in the number of voters and Donkey voting in the Senate as well as voting for non-major parties in the Senate. There does not appear to be a ready theoretical explanation for this behavior and the estimated parameter values are fairly small in magnitude. Overall, this set of placebo tests provides supporting evidence that the treatment effect estimated in the main results is a genuine effect and not a chance result of noise in the data.

Table 1.10: Placebo Test

	Dependent variable:				
	Total House Votes	Total Senate Votes	Senate Informal %	Senate Donkey %	Senate Other %
	(1)	(2)	(3)	(4)	(5)
Panel A - Standard					
Change in Margin	44.420	40.872	0.005	−0.007	−0.003
	(123.432)	(123.053)	(0.007)	(0.006)	(0.022)
Change in ln(Voters)	87.800	84.700	0.005	0.083***	0.050*
	(181.312)	(180.780)	(0.008)	(0.009)	(0.030)
Change in ln(N Options)	14.363	14.080	−0.001	−0.002	−0.020***
	(24.340)	(24.318)	(0.002)	(0.001)	(0.005)
Changed Division	8.223	8.396	0.0004	−0.0005	−0.012***
	(10.190)	(10.196)	(0.0004)	(0.0005)	(0.002)
Covariates	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓
Polling Place FE	✓	✓	✓	✓	✓
Observations (Polling Place × Year)	23,096	23,096	23,096	23,096	23,096
R^2	0.112	0.112	0.342	0.105	0.756
Panel B - Propensity Score Matched					
Change in Margin	167.477	167.086	−0.006	−0.008	−0.030
	(152.190)	(151.332)	(0.009)	(0.008)	(0.024)
Change in ln(Voters)	317.690	306.540	0.009	0.088***	0.100***
	(253.489)	(253.373)	(0.011)	(0.014)	(0.037)
Change in ln(N Options)	2.860	1.888	−0.002	−0.002	−0.005
	(31.565)	(31.563)	(0.002)	(0.002)	(0.006)
Changed Division	13.959	14.219	0.0001	−0.001	−0.014***
	(13.263)	(13.263)	(0.001)	(0.001)	(0.002)
Covariates	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓
Polling Place FE	✓	✓	✓	✓	✓
Observations (Polling Place × Year)	11,677	11,677	11,677	11,677	11,677
R^2	0.114	0.113	0.415	0.088	0.776

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. The dependent variable changes between each column, for Column 1 it is the total number of votes recorded in the House; Column 2 is the total number of votes recorded in the Senate; Column 3 is the percent of informal votes in the Senate; Column 4 is the percent of Donkey votes in the Senate; Column 5 looks at the share of votes for non-major parties (i.e. not Liberal, National, Labor or the Greens). Donkey voting is defined as when a voter votes for the first party on the ballot as their first preference. R^2 for FE models is the unadjusted 'within' R^2. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

1.4.3 Alternative stories

This section considers some alternative stories that could explain the results seen in the previous sections. First, there is the possibility that there are other variables not included in the main results, which are causing the observed effect for the change in number of options. One possibility is that a strong incumbent candidate may also affect the likelihood of submitting an informal vote and incumbency may be correlated with aspects such as margin and number of options.

The role of incumbency advantage in elections is frequently discussed in the literature. Papers such as Ansolabehere et al. (2000), Friedman & Holden (2009), and Desposato & Petrocik (2003) all analyze incumbency advantage with reference to electorate boundaries, while papers such as Lee (2008) and Carson et al. (2007) consider the source of incumbency advantage more broadly.

To account for the potential role of incumbency, the results in Table 1.11 include variables *ln(Tenure)* and *Change in ln(Tenure)*. Tenure is defined as the number of years that the incumbent has been representing the electorate at the time of the election. This variable is logged and differences applied in order to make its interpretation align with other variables in the previous section.

Another variable added in the results shown in Table 1.11 is the share of votes for progressive parties (defined as first preference votes for the ALP and Green parties). The potential effect of the strength of progressive parties on voting has been tested by Hill & Jones (2017), who show that progressive parties spend more on minorities relative to conservative parties, and Pettersson-Lidbom (2008) who find that progressive parties spend and tax 2-3% more than right wing parties. These findings are important as Bechtel & Hainmueller (2011) show that voters respond to increases in expenditure by increasing their vote for incumbents for at least two rounds of future elections. As a result, high progressive share of the vote may be associated with strong preferences for certain groups that experience the benefits of expenditure increases under progressive incumbents and this may affect the level of informal voting.

The results do not show statistical significance for either the *Change in ln(Tenure)* or the *Change in Progressive Vote Share* variables. The results for *Change in Margin*, *Change in ln(Voters)* and *Change in ln(N Options)* also remain similar to those in the main results. This suggests that the possible stories described above do not affect the results presented earlier.

Table 1.11: Main results – Including Tenure and Progressive Share

	Dependent variable: Informal %					
	Model specifications					
	OLS	OLS w. covariates	Fixed Effects	DID Standard	DID Propensity Score Matched	DID Distance Limited
	(1)	(2)	(3)	(4)	(5)	(6)
Margin	0.792***	−0.030	−3.547***	−3.422***	−5.329***	−5.565***
	(0.294)	(0.285)	(0.361)	(0.368)	(0.614)	(0.638)
ln(Voters)	1.859***	1.400***	0.863**	0.979***	3.259***	0.527
	(0.147)	(0.157)	(0.352)	(0.361)	(0.603)	(0.600)
ln(N Options)	0.790***	0.865***	2.155***	2.054***	2.170***	1.726***
	(0.051)	(0.054)	(0.057)	(0.057)	(0.097)	(0.112)
ln(Tenure)	−0.101***	−0.075***	−0.060***			
	(0.021)	(0.021)	(0.021)			
Progressive Vote Share (%)	0.552***	0.162	1.245***			
	(0.114)	(0.115)	(0.123)			
Change in Margin				−2.242**	−3.753***	−3.195***
				(0.907)	(1.097)	(0.936)
Change in ln(Voters)				−0.962	−0.508	−0.276
				(1.114)	(1.375)	(1.169)
Change in ln(N Options)				2.397***	2.501***	2.200***
				(0.206)	(0.260)	(0.209)
Change in ln(Tenure)				0.006	0.055	−0.037
				(0.066)	(0.085)	(0.066)
Change in Progressive Vote Share				0.188	0.991	0.724
				(0.856)	(1.143)	(0.892)
Changed Division				−0.322***	−0.538***	−0.294***
				(0.100)	(0.138)	(0.102)
Covariates		✓	✓	✓	✓	✓
Time FE		✓	✓	✓	✓	✓
Polling Place FE			✓	✓	✓	✓
Clusters (Polling Place)	5,930	5,930	5,930	5,930	4,195	1,955
Observations (Polling Place × Year)	23,096	23,096	23,096	23,083	11,677	7,470
Treated Observations	NA	NA	NA	1,415	1,063	1,415
Control Observations	NA	NA	NA	21,681	10,614	6,068
R^2	0.373	0.433	0.360	0.356	0.378	0.414

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Column 1 shows the results of a simple linear regression; Column 2 introduces a range of socioeconomic covariates; Column 3 introduces fixed effects for Polling Place. Columns 4-6 shows the results of the DID. Column 4 presents the main output, which uses voting in the House with treated Polling Places being those that moved between electorates and control Polling Places being those that did not move. Column 5 shows the same model but after propensity score matching to make the observable characteristics of treated and control groups similar has been applied; Column 6 shows results where the sample is limited to Polling Places within 2.5 kilometers of treated Polling Places. A variation was tried where the change in progressive vote share was split into an increase and a decrease variable, this did not materially affect the results presented above. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

An additional alternative story is related to the complexity of defining and understanding the margin in an Instant Runoff Voting system – as is used in the House in Australia. In this system, the margin is defined based on the share of votes in the final round of voting not on the share of first preference votes. This may make it more difficult for voters to understand and respond to the expected margin when placing their vote (as it requires some calculation of the flow of preferences throughout the runoff process). To address this, Table 1.12 presents a version of the main results where the margin is defined as the margin measured on first preferences (i.e., the number one preference on the ballots).

The results in Table 1.12 are similar to the main results with the exception that *Change in Margin* is not statistically significant in any specification. This result may reflect the fact that the first preference margin is not related to the chance of a voter being pivotal and so, in theory, shouldn't affect decisions around the benefits of casting a vote.

Finally, there is the possibility that voters on the margin between a decision to turnout or vote informally may be responsible for the results. The analysis in Table 1.13 reproduces the approach of the Main Results but increases the rate of non-voting by 1 percentage point on the assumption that all of this increase comes from voters who submit an informal ballot. The results are similar to those seen in the Main Results and are also similar to additional, unreported, sensitivity analyses based on a -1 and +2 percentage point change in non-voting. This suggests that this potential explanation is not responsible for the findings.

The results in this section confirm that the main results are retained even when considering a range of other potential explanations and variables that could affect decisions around informal voting.

1.5 Additional results: types of informal voting

There are a number of ways in which a ballot can result in an informal vote. For example, both a completely blank ballot and a ballot where the voter writes their name are recorded as informal. In general, the AEC classifies informal votes into one of the following categories:

Table 1.12: Main results – Margin Defined on First Preferences

	Dependent variable: Informal %					
	Model specifications					
	OLS	OLS w. covariates	Fixed Effects	DID Standard	DID Propensity Score Matched	DID Distance Limited
	(1)	(2)	(3)	(4)	(5)	(6)
Margin	0.898***	0.597***	0.238	0.237	−1.073***	−1.497***
	(0.150)	(0.125)	(0.163)	(0.167)	(0.275)	(0.315)
ln(Voters)	3.512***	1.203***	0.580*	0.686*	2.589***	0.165
	(0.193)	(0.158)	(0.349)	(0.359)	(0.590)	(0.613)
ln(N Options)	0.423***	0.888***	2.175***	2.157***	2.325***	1.831***
	(0.067)	(0.053)	(0.057)	(0.057)	(0.098)	(0.117)
Change in Margin				0.275	−0.349	−0.646
				(0.414)	(0.534)	(0.432)
Change in ln(Voters)				−0.890	−1.402	−0.326
				(1.112)	(1.385)	(1.157)
Change in ln(N Options)				2.524***	2.590***	2.348***
				(0.207)	(0.267)	(0.212)
Changed Division				−0.257***	−0.420***	−0.163**
				(0.065)	(0.091)	(0.065)
Covariates		✓	✓	✓	✓	✓
Time FE		✓	✓	✓	✓	✓
Polling Place FE			✓	✓	✓	✓
Clusters (Polling Place)	5,930	5,930	5,930	5,930	4,195	1,955
Observations (Polling Place × Year)	23,101	23,101	23,101	23,101	11,677	7,488
Treated Observations	NA	NA	NA	1,420	1,063	1,420
Control Observations	NA	NA	NA	21,681	10,614	6,068
R^2	0.030	0.433	0.349	0.350	0.369	0.404

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Column 1 shows the results of a simple linear regression; Column 2 introduces a range of socioeconomic covariates; Column 3 introduces fixed effects for Polling Place. Columns 4-6 shows the results of the DID. Column 4 presents the main output, which uses voting in the House with treated Polling Places being those that moved between electorates and control Polling Places being those that did not move. Column 5 shows the same model but after propensity score matching to make the observable characteristics of treated and control groups similar has been applied; Column 6 shows results where the sample is limited to Polling Places within 2.5 kilometers of treated Polling Places. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

Table 1.13: Sensitivity Analysis – Increasing Non-Voting by 1% from Informal Voters

	Dependent variable: Informal %					
	Model specifications					
	OLS	OLS w. covariates	Fixed Effects	DID Standard	DID Propensity Score Matched	DID Distance Limited
Margin	2.206***	−0.209	−3.241***	−3.457***	−5.338***	−5.546***
	(0.348)	(0.285)	(0.359)	(0.369)	(0.616)	(0.638)
ln(Voters)	3.559***	1.397***	0.887**	1.027***	3.356***	0.657
	(0.194)	(0.158)	(0.353)	(0.363)	(0.607)	(0.604)
ln(N Options)	0.469***	0.862***	2.090***	2.067***	2.200***	1.762***
	(0.067)	(0.054)	(0.057)	(0.058)	(0.098)	(0.114)
Change in Margin				−2.226**	−3.538***	−3.238***
				(0.898)	(1.047)	(0.923)
Change in ln(Voters)				−0.851	−0.543	−0.115
				(1.120)	(1.379)	(1.174)
Change in ln(N Options)				2.394***	2.536***	2.225***
				(0.207)	(0.265)	(0.211)
Changed Division				−0.298***	−0.450***	−0.215***
				(0.065)	(0.092)	(0.066)
Covariates		✓	✓	✓	✓	✓
Time FE		✓	✓	✓	✓	✓
Polling Place FE			✓	✓	✓	✓
Clusters (Polling Place)	5,930	5,930	5,930	5,930	4,195	1,955
Observations (Polling Place × Year)	23,096	23,096	23,096	23,096	11,677	7,483
Treated Observations	NA	NA	NA	1,415	1,063	1,415
Control Observations	NA	NA	NA	21,681	10,614	6,068
R^2	0.030	0.433	0.355	0.356	0.380	0.413

Note: The data has been manually adjusted to artificially increase the rate of non-voting by 1 percentage point by reducing the number of informal votes. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level Column 1 shows the results of a simple linear regression; Column 2 introduces a range of socioeconomic covariates; Column 3 introduces fixed effects for Polling Place. Columns 4-6 shows the results of the DID. Column 4 presents the main output, which uses voting in the House with treated Polling Places being those that moved between electorates and control Polling Places being those that did not move. Column 5 shows the same model but after propensity score matching to make the observable characteristics of treated and control groups similar has been applied; Column 6 shows results where the sample is limited to Polling Places within 2.5 kilometers of treated Polling Places. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

1. Totally blank;
2. Incomplete numbering – number 1 only;
3. Incomplete numbering – other;
4. Ticks and Crosses;
5. Other symbols;
6. Non-sequential numbering;
7. Scribbles, slogans and other protest vote marks Illegible numbering;
8. Voter identified; and
9. Other.

These categories can be broadly split between intentionally informal votes and unintentionally informal votes. Unintentional informal votes are defined as ballots with incomplete numbering, non-sequential numbering, ticks and crosses, and ballots in which the voter is identified; all other informal votes are classified as intentionally informal (Australian Electoral Commission, 2016b).

Data on the type of informal vote isn't systematically gathered or available at a Polling Place level, making causal analysis impossible within the framework set out in Section 1.2.[13] The AEC has, however, undertaken reviews of informal voting at the electorate level for a number of recent elections and this data provides additional insight into how socioeconomic characteristics correlate with informal voting.

Table 1.14 provides results of regressions where the dependent variable is the percentage (0-100) of different types of informal votes. In this analysis, the observation level is the electorate and data is included for the elections of 2007, 2010, and 2013. The analysis aggregates categories reported by the AEC. The Non-numeric category aggregates ballots with ticks, crosses

[13] Communication with the AEC indicated that this data is not available even in an unpublished format.

and symbols while the Other category aggregates ballots where the voter is identified, the vote is illegible, and the AEC's "other" category.

Table 1.14: Contributors to Types of informal Voting (as percentage of all votes in electorate)

	Dependent variable: Informal type share of total votes							
	Intentional		Unintentional					
	Blank	Scribble	One only	Non-sequential	Non-numeric	Incomplete	Other	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Margin (%)	1.268*	0.467	−0.578	0.598	0.425	−0.559	−0.037	1.583
	(0.679)	(0.489)	(1.879)	(0.898)	(0.670)	(0.436)	(0.176)	(3.259)
ln(Voters)	−0.021	0.111***	−0.133	−0.007	−0.079***	0.013	−0.0004	−0.117
	(0.060)	(0.036)	(0.082)	(0.044)	(0.026)	(0.017)	(0.010)	(0.171)
ln(N Options)	0.829***	−0.047	−0.565**	1.771***	−0.208*	0.582***	0.117***	2.479***
	(0.137)	(0.076)	(0.271)	(0.241)	(0.121)	(0.090)	(0.029)	(0.579)
Median Age	0.011	0.012	−0.037	−0.017	0.0001	−0.028***	−0.001	−0.060
	(0.020)	(0.013)	(0.045)	(0.024)	(0.015)	(0.010)	(0.004)	(0.085)
ln(Mean Income (000))	1.851***	0.051	2.812**	−0.794	2.067***	−0.177	−0.224*	5.585***
	(0.419)	(0.246)	(1.257)	(0.634)	(0.468)	(0.241)	(0.127)	(1.994)
Unemployment (%)	0.017	−0.004	0.322***	−0.039	0.106**	0.031	−0.006	0.428**
	(0.041)	(0.024)	(0.106)	(0.052)	(0.041)	(0.023)	(0.009)	(0.198)
Population Density	0.0002**	0.00003	0.0005***	−0.00004	0.0002***	0.00001	0.00002*	0.001***
	(0.0001)	(0.00004)	(0.0002)	(0.0001)	(0.0001)	(0.00004)	(0.00001)	(0.0003)
Population Growth (%)	−0.060	0.130***	−0.328***	0.037	−0.141***	0.013	0.043***	−0.305*
	(0.040)	(0.032)	(0.108)	(0.059)	(0.041)	(0.023)	(0.011)	(0.185)
Population Decline (%)	0.377	0.768**	−2.007**	0.838	−0.487	−0.059	0.230***	−0.340
	(0.509)	(0.342)	(0.935)	(0.597)	(0.320)	(0.225)	(0.088)	(1.729)
ln(House Value (000))	−0.322*	−0.130	0.971**	0.313	−0.129	0.199*	−0.028	0.874
	(0.175)	(0.098)	(0.420)	(0.230)	(0.172)	(0.102)	(0.038)	(0.864)
English 2nd Language (%)	0.039***	0.017***	0.056***	0.025***	0.027***	0.009***	0.003**	0.176***
	(0.005)	(0.002)	(0.014)	(0.005)	(0.005)	(0.003)	(0.001)	(0.025)
Tertiary Degree (%)	−0.093***	−0.021***	−0.172***	−0.019	−0.074***	−0.010*	0.002	−0.386***
	(0.010)	(0.006)	(0.028)	(0.012)	(0.011)	(0.005)	(0.003)	(0.050)
Time FE	✓	✓	✓	✓	✓	✓	✓	✓
Share of informal (%)	23.6	16.1	28.1	13.9	11.3	4.5	2.6	100.0
Observations	429	429	429	429	429	429	429	429
R^2	0.748	0.567	0.517	0.468	0.589	0.499	0.316	0.687

Note: *p<0.1; **p<0.05; ***p<0.01

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the electorate level. The results above aggregate categories reported by the AEC. The Non-numeric category aggregates ballots with ticks, crosses and symbols while the Other category aggregates ballots where the voter is identified, where the vote is illegible and the AEC's other category. The dependent variable is defined as the number of a specific type of informal vote divided by the total number of votes (both valid and informal). Time period fixed effects use 2007 as the reference year. *p<0.1; **p<0.05; ***p<0.01

Of note in these results is that more options on the ballot are associated with higher levels of blank, non-sequential and incomplete informal votes, indicating the challenges and costs of completing larger ballots. A higher margin is also associated with higher levels of blank ballots, which is a type of intentional informal voting.

Turning to socioeconomic factors, higher levels of income are associated with more blank ballots, potentially relating to the opportunity cost of completing a ballot. Areas with higher levels of English as a second language tend to have higher levels of informality across the board but with a notably strong effect on increasing the number of blank, one-only, non-sequential and non-numeric ballots -– likely reflecting errors or misunderstandings in completing the ballot. This is similar in nature to the findings in Power & Roberts (1995) that recently enfranchised voters in Latin America are particularly likely to make errors on complex ballots. Galatas (2008) also finds that the percentage of immigrants is robustly positively correlated with the proportion of informal votes in Canada.

Higher levels of tertiary education tend to reduce almost all types of informal voting, but the effect is strongest on informal votes where there is only a one on the ballot, numbering is non-numeric, and a blank ballot. Education levels appear to have a weaker relationship with non-sequential numbering on ballots and incomplete numbering. As non-sequential and incomplete numbering tend to represent unintentional informal voting, these results support the idea that better educated voters may consider the strategic implications of their voting decisions more closely than other groups. This interpretation is similar to results seen in Driscoll & Nelson (2014) and Cohen (2018) who both find evidence that, in Latin America, voters that are high in knowledge protest poor government performance by submitting blank ballots in compulsory voting elections.

While the results in this section do not have a causal interpretation, they provide further support for the main findings. In particular, these results show that more options on a ballot are associated with higher levels of blank, non-sequential and incomplete informal votes and that voters in areas with higher levels of education are less likely to unintentionally vote informally, indicating more strategic voting behavior.

1.6 Conclusion

We find support for the hypothesis that informal voting will be higher when there are more options available on the ballot (H3) but we do not find support for the hypotheses that informal voting will be higher when the expected margin in an election is higher (H1); nor that informal voting will be higher when there are more voters in an electorate (H2).

Once a voter has incurred travel and time costs to arrive at the polling place and is considering whether to vote or not, their decision to not vote is largely driven by the costs of thinking about and ranking their options rather than factors that may affect their likelihood of being pivotal in the election. This is supported by non-causal analysis that finds that more options on the ballot is associated with higher levels of blank, non-sequential and incomplete informal votes – all indicative of time and complexity costs. The choice not to vote seems to be primarily affected by cost of voting and not the potential benefit.

The subgroup analysis for voters with higher levels of education indicates that their response to the number of candidates is similar to those with lower levels of education, but their response to competitiveness is aligned with theory. This suggests that better educated voters may consider the strategic implications of their voting decisions more closely than other groups, but that the behavior around the number of options on a ballot isn't explained by differences in levels of education. This is also supported by non-causal analysis that shows that voters in better educated areas are less likely to make involuntary informal votes.

The lack of support for H1 and H2 is in contrast to the theoretical literature, where an increase in the margin or the number of voters should lead to an increase in informal voting. These findings are also contrary to those in recent papers, such as Lyytikäinen & Tukiainen (2019). The result that the number of options available on the ballot leads to an increase in informal voting, is also contrary to recent findings reported in Nagler (2015).

One potential reason that the results in this paper are contrary to those seen in other recent papers is that no previous paper has tested these contributors to voting behavior in a single model. Further, many tests of both these theories have not focused strongly on a research design that makes use of exogenous variation in the key parameters of interest.

These results are more in line with those seen in Iyengar & Kamenica (2010) or Iyengar & Lepper (2000), which show that – in general cases, larger choice sets can lead decision-makers to abstain from making a decision. These findings are also similar to those in Augenblick & Nicholson (2016) who show that more decisions on the same ballot can increase abstention. The results show mixed support for the implications of Feddersen and Pessendorfer's theory of voter abstention, where uninformed voters abstain to allow the outcome of the election to be controlled by informed voters (Feddersen & Pesendorfer, 1996). The general relationship between education and the level of informal voting is as implied by their theory, whereby more informed voters are less likely to abstain from voting; however, the statisticallypositive and significant parameter estimate for Change in Margin for highly educated voters is counter to their theory.

Going beyond the implications for theory, the results are also informative from a practical point of view. This is because, in some electorates in Australia, the number of informal votes can be greater than the margin. For example, in the 2016 election, the seat of Gilmore had a margin of around 400 votes with almost 4,000 informal votes, while the seat of Hindmarsh had a margin of around 430 votes and with approximately 3,000 informal votes. Figure 1.7 shows that, in total, around 32% of contests have more informal votes than the margin.

The frequency of informal voting exceeding the margin suggests that informal voting may have practical consequences for outcomes of elections. Policies that affect the level of informal voting across a large number of voters may, therefore, affect the final composition of Parliament and the economic and social policies that are ultimately implemented by the government. The findings in this paper suggest that increasing the rate of formal voting could be achieved by strategies that make it easier for voters to research, understand and rank the candidates on the ballot – in short: making it easier to vote.

One potential approach to simplify voting in Australia would be to allow a non-exhaustive ranking of candidates in the House, as is done in the Senate and in some Australian states. While data on the full preference listing for ballots is not available, some data on the flow of preferences in counting is made available by the AEC, allowing for a reconstruction of how often preferences are used in counting votes. Analysis of this data shows that approximately 10.5 million of the roughly 13.5 million ballots counted in the 2016 election ended up being

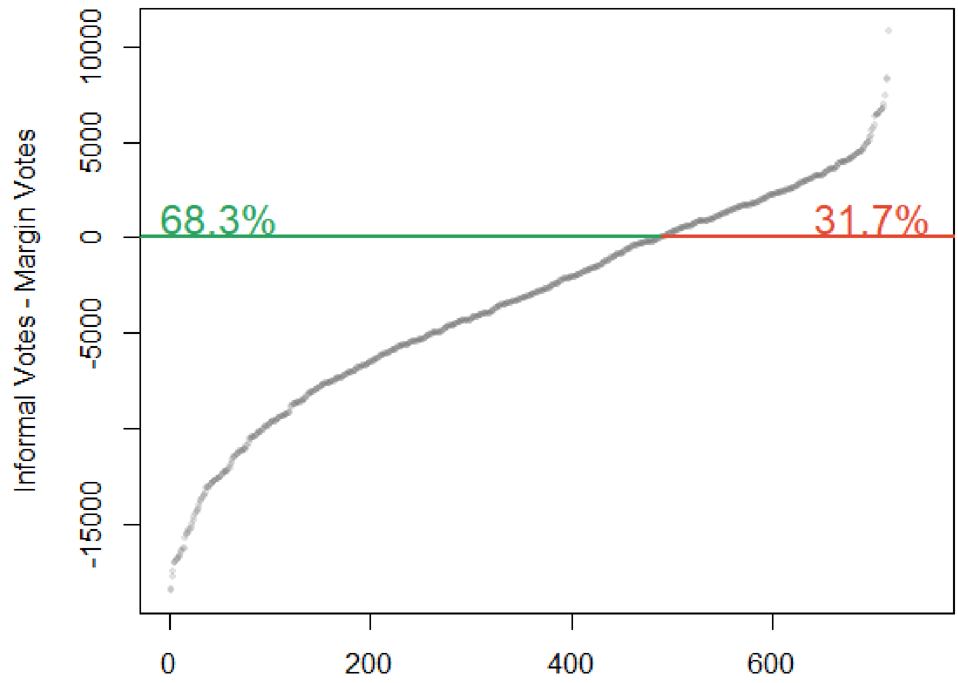


Figure 1.7: Difference between Number of Informal Votes and Margin

Note: Data is at the electorate level covering the years 2004-2016.

Source: Authors' calculations based on multiple data sources from the Australian Electoral Commission and Australian Broadcasting Corporation (2019).

counted against their first preference. Further, around 12.5 million voters (92% of all voters) had to rank five or more candidates on their ballot while fifth or higher preferences were only used in around 10,500 ballots (less than 0.1% of all ballots). This suggests that the requirement to exhaustively rank all candidates on the ballot is not often used when counting votes and may contribute significantly (in both statistical and practical terms) to the level of informal voting. Moving to a simplified process for stating preferences in the House could generate benefits in terms of reducing informal voting without significant costs.[14]

Finally, considering paths for future research in this area, an alternative explanation of the results is that the presence of compulsory voting in Australia, by eliminating the role of travel and time costs in the voting decision, minimizes the role of margin and number of voters while leaving choice costs unchanged. That is, under compulsory voting, voters no longer consider how likely they are to affect the results of the election but only focus on their choice costs. To address whether this explanation is correct would require applying a similar research design to elections held under a voluntary voting regime, such as in the United States. Assigning a causal interpretation to any differences between two countries would be problematic as the design of electoral systems and voting behavior are likely to be jointly determined.

[14]The analysis and policy suggestions do not take into account other effects that would likely happen in a real world situation where significant changes were made to voting procedure, such as changes in the political positions of the candidates or their electoral strategies.

2

Influence of personal ideology in politician's speeches on Same Sex Marriage

In late 2017, Australia held an official national survey on whether Same Sex Marriage (SSM) should be legalised, called the Australian Marriage Law Postal Survey (AMLPS). The AMLPS was non-binding and conducted by the Australian Bureau of Statistics (Australia's national statistical agency). Unlike voting in Australian parliamentary elections, constitutional referenda, plebiscites, or the Census, participation in AMPLS was not mandatory. The unusual approach of an official survey was due to insufficient support for a plebiscite in parliament. In the rest of this chapter, the AMLPS is simply referred to as a 'vote'.

The national vote provided politicians with new and thorough information on the position of their electorate with respect to SSM. The national vote was followed by a brief period where politicians debated SSM legislation in parliament with a high level of scrutiny from the media and voters. The national vote therefore involved a fast, clear and closely monitored method of communication between the electorate and politicians where new information was made available to politicians on a single, politically charged topic. In contrast, most feedback between electorates and politicians is slow, involves complex policy spaces and is often not well reported or monitored by the public at large.

Overall, the outcome of the national vote identified strong support for legalizing SSM but with important differences at the electorate level and for individual politicians. For example, there was a majority "No" vote in 17 of the 150 electorates and, in 12 of these electorates, the local Member of Parliament was in favor of SSM (Australian Marriage Equality, 2019).

The context and results of the SSM national survey provide a unique opportunity to identify the role that ideology and the position of the electorate play in determining the behavior and decisions of politicians. While not present in the seminal model of Downs (1957), the potential role of personal ideology for elected officials is established theoretically in the models of Alesina (1988), Osborne & Slivinski (1996) and Besley & Coate (1997). These models have found support in recent empirical literature, such as Levitt (1996), Lee et al. (2004), Lee (2008), Albouy (2011), Button (2018), and Jones & Walsh (2018). This recent empirical literature uses analysis of roll-call-voting[1] to show that politicians don't merely reflect the position of the median voter but also place weight on their own ideology, the position of their supporters and the position of their party (this emerging consensus is referred to as 'partial convergence').

Instead of using roll-call-voting to analyse the role of ideology and the electorate, I extend the existing literature into the area of political speech by making use of the text-based techniques applied to political polarization by Gentzkow et al. (2019b) and described in detail in Gentzkow et al. (2019a). I start with data compiled by Australian Marriage Equality (2019)

[1] Analysis of roll-call-voting requires a composite measures of voting over time, such as the ADA score, as the outcome variable. This has a number of drawbacks including that the scores are generated by a subjective process often for a political purpose; that the scores are also only calculated over longer periods of time (normally around a year) and so more suited for analysis of long run trends rather than immediate effects; and that they may not be directly comparable over time.

on the known stance of representatives on the issue of SSM. Parliamentary speeches are then processed into a large and sparse matrix representing the speech as data. I then use a LASSO model to select the phrases that are most important for predicting whether a speech is given by a representative known to support or oppose SSM. A predicted value for each speech is used to assign a score on how likely the speech is to have been delivered by a Supporter of SSM. The scores for each speech are then used in further reduced form analysis which directly addresses the question of how representatives responded to their electorate's position. More detail on this approach is provided in Section 2.4.

The use of a text-as-data approach to analyse speeches has the advantage over existing empirical approaches in the papers discussed above of being less subjective, more nuanced, and providing more timely responses to new information than roll-call-voting. The text-based approach also allows for analysis of behavior relating to a single vote on one topic, rather than needing to rely on compound and subjective measures of politician's voting behavior over a long period.

Analysis of the political response to the SSM vote can also inform current debates around the presence and causes of polarization in politics. Over at least the last five years, there has been increased public attention on the potential role of polarization in contemporary politics. This recent focus reflects a long running increase in perceived polarization in society since the 1980's (Gentzkow, 2016). The literature on polarization is, however, mixed in its findings of whether polarization is a growing issue as well as its source. For example, Bishop (2004), Abramowitz & Saunders (2008), and Gentzkow et al. (2019b) find evidence of increasing polarization while Fiorina & Abrams (2008), Glaeser & Ward (2006) and Ansolabehere et al. (2006) do not find evidence in support of increasing polarization. As the SSM national survey relates to a politically charged and potentially polarizing moment, analysis of politicians' behavior can provide some insight on the mechanisms that can lead to polarization.

The results of the analysis indicate that Opposers of SSM tended to become stronger in their opposition to SSM once the results of the SSM national survey were released – the average Opposer increased their opposition by 0.15-0.2 on a scale of 0-1. This strengthening of opposition occurred regardless of the position of their electorate. No consistent and statistically significant change is seen in the behavior of Supporters of SSM. This result indicates that personal ideology played a more significant role in determining political behavior than did the position of the electorate. Further, the fact that the observed positions of Supporters and Opposers of SSM moved further apart indicates that polarization did take place.

This paper is set out so that Section 2.1 provides a background on the SSM issue in Australia and the context for the national survey. Section 2.2 then provides an overview of relevant literature. The following sections provide details on the analytical approach with Section 2.3 covering data sources and cleaning of text and Section 2.4 covering assignment of scores to speeches. Section 2.5 presents a graphical analysis, more formal main results, a series of robustness checks, and analysis of heterogeneity among individual politicians. Section 2.6 concludes.

2.1 Background

The Federal parliament in Australia is made up of two houses: the House of Representatives and the Senate. The House of Representatives has 150 members who each represent a single geographic area (normally called an 'electorate' or 'seat'). The Senate has 76 senators, each state in Australia has 12 senators to represent it while each territory has 2 senators to represent it.

Among a range of powers, the Australian constitution gives the Federal Government legislative powers relating to marriage. Since 1961, the Commonwealth has exercised its marriage powers through the *Marriage Act 1961*. Up until 2004, the Act did not contain a specific definition of marriage and the common law definition deriving from the English case *Hyde v Hyde (1866)* applied. The application of this common law definition essentially meant that marriage was defined as the voluntary union for life of one man and one woman, to the exclusion of all others. As the Federal Government retains powers relating to marriage, any law made by a state or territory in Australia that is inconsistent with the Marriage Act is invalid. Therefore, until 2004, this common law definition applied across all of Australia.

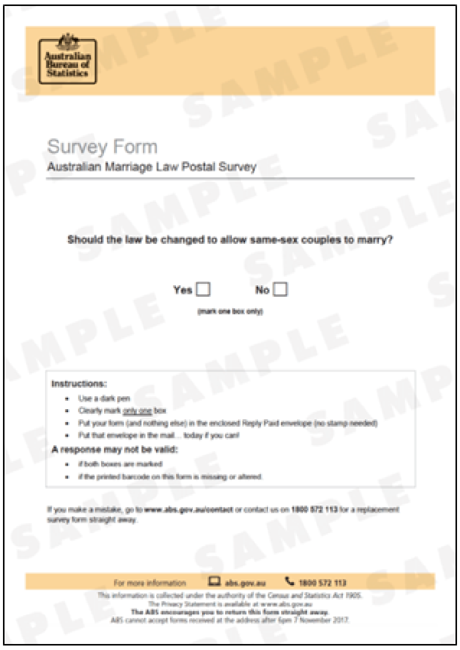
In 2004, the Commonwealth Government passed the *Marriage Amendment Act 2004* that specifically defined marriage as the union of a man and a woman to the exclusion of all others, voluntarily entered into for life – making explicit the existing common law definition.

Between 2004 and 2016, at least 20 countries legalized SSM including many that are similar to Australia in terms of culture and economic development such as Canada, New Zealand, England, and the United States.

As part of the 2016 election, the Liberal National coalition (LNP) (who would go on to win the election) proposed to undertake a national plebiscite on whether SSM should be made lawful in Australia. A plebiscite involves a compulsory vote on a specific, non-constitutional issue. However, following the 2016 election, the Senate refused to support the legislation to establish a plebiscite, thus, the Government decided to conduct a voluntary postal survey. Between September and November 2017, the postal survey was conducted. The goal of this survey was to gather information on the position of the Australian electorate on whether SSM should be legalized in Australia. The survey was not binding on politicians in any way but did present a way for voters to convey their position on this topic to their representatives in parliament.

The survey was administered by the Australian Bureau of Statistics (ABS) and was carried out via post. A survey ballot was sent to every person registered to vote in Australia with participation being voluntary. The survey consisted of a single question "Should the law be changed to allow same sex couples to marry?" with two tick box options of "Yes" and "No". An example of the ballot is shown in Figure 2.1.

The national survey was a controversial and financially costly plan. The survey was initially budgeted to cost around $122 million (it eventually cost taxpayers around $80.5 million) (Australian Bureau of Statistics, 2018a). At the time of the survey, some commentators believed that this expenditure was wasteful as the results of the survey would not bind representatives and the overall result, based on a range of nationally representative polls, suggested that the national vote would be strongly in favor of marriage equality. Further, commentators


Australian Bureau of Statistics

Survey Form
Australian Marriage Law Postal Survey

Should the law be changed to allow same-sex couples to marry?

Yes ☐ **No** ☐

(mark one box only)

Instructions:
- Use a dark pen
- Clearly mark only one box
- Put your form (and nothing else) in the enclosed Reply Paid envelope (no stamp needed)
- Put that envelope in the mail... today if you can!

A response may not be valid:
- if both boxes are marked
- if the printed barcode on this form is missing or altered.

If you make a mistake, go to **www.abs.gov.au/contact** or contact us on **1800 572 113** for a replacement survey form straight away.

For more information **abs.gov.au** **1800 572 113**

This information is collected under the authority of the Census and Statistics Act 1905.
The Privacy Statement is available at www.abs.gov.au
The ABS encourages you to return this form straight away.
ABS cannot accept forms received at the address after 6pm 7 November 2017.

Figure 2.1: Example of the National Survey on SSM
Source: Australian Bureau of Statistics (2018b)

considered that extended debate on the topic had the potential to be divisive within the populace, hurtful to particular groups and to distract from other prominent political challenges (Verrelli et al., 2019). These perceptions were aired in national media with, for example, Tony Walker writing in the Sydney Morning Herald and describing the national survey as a time-wasting and costly diversion 2017.

The survey results were released on 15 November 2017. Nationwide, the survey had a total turnout of around 12.7 million voters (79.5% of all those eligible to vote). Around 7.8 million (61.6%) voted "Yes", 4.8 million (38.4%) voted "No" and an additional 37,000 (0.3%) responses were unclear. This means there was a strong majority in favor of legalizing SSM in Australia at the national level.

Following release of the survey results, there was a period of debate in parliament around the *Marriage Amendment (Definition and Religious Freedoms) Bill 2017*. Following debate, the bill passed the Senate on 29 November 2017 and the House of Representatives on 7 December 2017. In the Senate, the bill passed with 43 votes for, 12 votes against and 17 abstentions while in the House it passed with 128 votes for, 4 against and 16 abstentions.

Overall, the outcome of the national survey identified strong support for legalizing SSM with the vote in parliament broadly reflecting the popular vote. However, this outcome masks important differences at the electorate level and for individual Members of Parliament. There was a majority of "No" votes in 17 of the 150 electorates and, in many of these electorates, there were strong disconnections between the positions of the voters and their representatives. In particular:

- 11 of the electorates that voted majority "No" had representatives from the Australian Labor Party (ALP) – a party that was officially pro-marriage equality.
- 12 of the electorates that voted majority "No" had representatives who were generally considered to be in favor of marriage equality (Australian Marriage Equality, 2019).
- 13 of the electorates that voted majority "No" had representatives who ended up voting in support of the legislation that was put to parliament following the national survey.
- Only 2 of these electorates had a representative who was a known Opposer of SSM and who voted against the legislation.

A summary of these combinations is presented in Table 2.1. These results present an unusually strong and clear mismatch between the position of an electorate and its representative on an important political issue[2].

The mismatch shown in Table 2.1 is particularly striking as the national survey and subsequent political outcomes of the SSM debate in Australia have features that should make the position of the electorate particularly salient for politicians. This was a national level survey on a single issue that can be directly mapped into a single policy dimension. The survey was followed by a brief period of time before the end of parliament's session in 2017 when politicians acted in response to the survey with a strong national focus on the outcome. That is, this situation involves a fast, clear and closely monitored method of communication and re-

[2] A similar disparity was not generally seen among electorates that voted strongly in favour of SSM. Full results are presented in Appendix C.

Table 2.1: Seats that voted majority No in the national survey

Division	Yes Percentage	Representative	Party	Position	Vote
Blaxland	26.1	Jason Clare	ALP	Supporter	For
Watson	30.4	Tony Burke	ALP	Supporter	For
McMahon	35.1	Chris Bowen	ALP	Supporter	For
Fowler	36.3	Chris Hayes	ALP	Opposed	For
Werriwa	36.3	Anne Stanley	ALP	Supporter	For
Parramatta	38.4	Julie Owens	ALP	Supporter	For
Chifley	41.3	Ed Husic	ALP	Supporter	For
Calwell	43.2	Maria Vamvakinou	ALP	Unknown	For
Barton	43.6	Linda Burney	ALP	Supporter	For
Maranoa	43.9	David Littleproud	LNP	Opposed	Against
Banks	44.9	David Coleman	LNP	Supporter	For
Greenway	46.4	Michelle Rowland	ALP	Supporter	For
Kennedy	46.7	Bob Katter	KAP	Opposed	Against
Bruce	46.9	Julian Hill	ALP	Supporter	For
Mitchell	49.1	Alex Hawke	LNP	Opposed	Abstain
Groom	49.2	John McVeigh	LNP	Opposed	For
Bennelong	49.8	John Alexander	LNP	Supporter	NA

Notes: ALP stands for Australian Labor Party, LNP stands for Liberal National Coalition, KAP stands for Katter's Australia Party. 'Position' is as categorized by Australian Marriage Equality (2019) and 'Vote' records the vote in the House of Representatives on the third reading of the *Marriage Amendment (Definition and Religious Freedoms) Act 2017* held on 7 December 2017. Full results are presented in Appendix C.
Source: Australian Bureau of Statistics (2017), Australian Marriage Equality (2019), Australian Parliament (2017)

sponse between the electorate and politicians. In contrast, most feedback between electorates and their representatives is slow – potentially with years between elections –, involve complex policy spaces and is often not well reported or monitored.

2.2 Relevant literature

The recent theoretical and empirical literature on the role of personal ideology and the electorate's position builds on the median voter theorem, as derived from Downs (1957). In the Downsian model, politicians do not have an ideological bias and are only interested in being elected to office. In particular, politicians maximize the probability of taking office because they receive positive utility when they are in power (Acemoglu, 2010). The main theoretical result within this Downsian model is the well-known median voter theorem, where politicians are predicted to converge on the preferred policy position of the median voter in their electorate. The result is theoretically robust to more complicated environments. For example, Calvert (1985) considers politicians who have a personal ideal point x^* and maximize a distance-based utility function $u_i(x^*)$, i.e. candidates are policy motivated rather than office motivated. In this approach, Calvert (1985) shows that convergence is maintained in settings where there are multiple dimensions of political competition, when assumptions about candidate motivation are relaxed and when assumptions about the candidate's information about the electorate are relaxed.

The median voter theorem and its alternatives have been the subject of extensive empirical testing. An influential applied paper in economics that analyzed the relevance of the median voter theorem is Lee et al. (2004). Lee et al. are interested in whether voters affect or elect policies. Under the Downsian model, voters will affect policies as candidates move towards the position of the median voter while, under an alternative model, voters will elect policies through selecting the politician. Lee et al. test this hypotheses using a regression discontinuity design with the discontinuity coming from very close elections (less than 2% margin) which essentially means that the winning candidate is assigned at random. The evidence suggests that, instead of policy convergence, as would be expected under the Downsian model, there is policy divergence. Lee (2008) provides further consideration of conditions required for causal inference in this framework that supports the earlier findings. Albouy (2011) undertakes an analysis of Senators and finds similar results (although finding that Senator's mediate their position prior to their next election). The original analysis of Lee et al. (2004) has also recently been reproduced by Button (2018) using more contemporary econometric methods with many of the same findings.

Other recent empirical work in this area from Jones & Walsh (2018) uses electoral boundary changes as the source of identification. They find that around 40% of the shift in policy following a redistribution is driven by changes in the policy position of elected representatives while 60% is driven by changes in the elected party. These findings are similar to those of Levitt (1996) although using a completely different model and identification strategy. Levitt (1996) constructs a simple model for estimating the proportional influence of personal ideology, electorate ideology and party ideology on a Senator's voting behavior. Levitt's politicians maximize a simple quadratic loss utility function:

$$\begin{aligned} U_{it} = - \Big[&\alpha \left(V_{it} - S_{it} \right)^2 + \beta \left(V_{it} - C_{it} \right)^2 + \gamma \left(V_{it} - P_{it} \right)^2 \\ &+ (1 - \alpha - \beta - \gamma) \left(V_{it} - Z_{it} \right)^2 \Big], \end{aligned} \tag{2.1}$$

where V_{it} is politician i's voting profile during year t, S_{it} is the bliss point of the politician's voters, C_{it} is the bliss point of the politician's supporters, P_{it} is the bliss point of the politician's party and Z_{it} is the politician's ideological bliss point. Levitt finds that personal ideology accounts for around 50-70 per cent of the motivation of voting behavior.

Overall, this empirical literature provides evidence that the implications of the rational choice theory of political competition are not fully borne out by the data. Ferreira & Gyourko (2009) conclude that "there is now a consensus that U.S. congressional voting behavior is highly partisan, with...new research design[s] confirming previous results". The main conclusion of this empirical literature is that elected representatives place a relatively small weight on the position of their electorate and tend to place more weight on their own ideological position or that of their party.

This emerging empirical consensus suggests that some of the alternative models, such as those of Alesina (1988), Osborne & Slivinski (1996) and Besley & Coate (1997), where politicians seek to implement their own preferred political position rather than converge on the position of the median voter in their electorate, may be appropriate models for understanding political behavior. Both Osborne & Slivinski (1996) and Besley & Coate (1997) propose models where policy decisions are undertaken in a representative democracy that has candidates drawn from the pool of voters. In Besley & Coate's approach, the primitives of the model are the voters and their preferences. Voters have a utility function $V_i(x_i^*, j)$ that combines a distance-based component that focuses on their preferred policy position, x_i^*, and an ego rent that depends on which individual, j, holds office. Voters choose to become candidates through an entry stage where any citizen can enter as a candidate at a given cost; candidates therefore inherit a set of preferences over political positions. The model has many possible equilibria but, often, there will be many two candidate equilibria where the candidates are 'far apart'. These models therefore do not predict any central tendency for political outcomes but instead predict a form of extremism balanced on either side of the median voter.

The recent empirical literature uses analysis of roll-call-voting as the dependent variable. This requires developing a composite measures of voting over time, such as the Americans for Democratic Action (ADA) score[3], and has a number of drawbacks. These drawbacks include that the scores are generated by a subjective process often for a political purpose; that the scores are also only calculated over longer periods of time (normally around a year) and so are more suited for analysis of long run trends rather than immediate effects; and that scores may not be directly comparable over time.

Instead of using roll-call-voting to analyse the role of ideology and the electorate, I make use of the text-based techniques that have emerged from the literature on polarization (Gentzkow et al., 2019b)[4]. The empirical literature on polarization is highly mixed in its findings of both whether polarization is a growing issue as well as on the source of polarization. Most papers in this area analyse changes in polarization in the U.S. over the last 20-40 years. For example, Bishop (2004) and Abramowitz & Saunders (2008) find evidence of increasing polarization

[3] The ADA score gives each member a Liberal Quotient (LQ) rating from 0, meaning complete disagreement with ADA policies, to 100, meaning complete agreement with ADA policies with 0 representing 'conservative' and 1 representing 'progressive' positions.

[4] The methodology used in this paper is described in detail in Gentzkow et al. (2019a)

while Fiorina & Abrams (2008), Glaeser & Ward (2006) and Ansolabehere et al. (2006) do not find evidence in support of increasing polarization. One weakness in this literature is that these papers tend to draw together a range of illustrative statistics to provide a general view of polarization rather than using a unified econometric approach.

In a departure from existing literature on polarization, Gentzkow et al. (2019b), introduce a text-based approach to analyzing polarization and find evidence of increasing polarization among US representatives since 1994. Essentially, Gentzkow et al. (2019b) measure the ease with which an observer could guess a speaker's political party based on listening to their speech and find that the ability to guess correctly increased after 1994 in the United States, suggesting an increase in polarization. They identify that this increase occurred within (rather than between) topics and was particularly focused on key areas of domestic policy. The findings of Gentzkow et al. (2019b) are consistent with analysis of survey data from Baldassarri & Park (2016) that shows polarisation within particular economic and civil rights issues from the early 1990s.[5]

The approaches developed by Gentzkow et al. (2019b) allow for analysis of political behavior that is less subjective and more timely than the use of roll-call-voting that is generally relied on in the empirical literature on partial convergence. This is particularly important in the context of the SSM national survey as the text based approach allows for analysis of behavior relating to a single vote on one topic, rather than needing to rely on compound and subjective measures of voting behavior over a long period of time.

In addition to bringing techniques from the literature on polarization to bear on the question of partial convergence, analysis of the political response to the SSM national survey in Australia can also inform current debates around the presence and causes of polarization in politics. As the SSM national survey relates to a politically charged and potentially polarizing moment, analysis of politician's behavior can provide some insight on polarization.

[5] The potential power of polarization in speech and communications is shown in a working paper from Long et al. (2019) which finds that conservative media's dismissals of hurricane warnings in 2017 resulted in Republican voters being around 25% less likely to evacuate than Democratic voters.

2.3 Data sources and preparation

The main data sources used in the analysis are the results of the SSM national survey (Australian Bureau of Statistics, 2017), text of parliamentary speeches (Australian Parliament, 2018), and data on each parliamentarian's position on SSM (Australian Marriage Equality, 2019). Other data sources that I use include data on politicians' demographic characteristics (mySociety Limited, 2018), and data on electorates and electoral outcomes (Australian Broadcasting Corporation, 2019).

The results of the national survey were published by the ABS in 2017 and provide data at the electorate level for the number of votes for "Yes" and "No". Other supporting data, such as the number of clear responses, unclear responses, and non-responses is also recorded at the electorate level (Australian Bureau of Statistics, 2017).

Parliamentary speeches were sourced from the Hansard records of the Australian Parliament for both the House of Representatives and The Senate (Australian Parliament, 2018). Hansard records from 2014 onwards were used as a single party was in control of Government throughout this period. It's likely that speech patterns change depending on which party is in Government and so, by focusing on data from this time period, this potential source of variability is removed.

Data on the position of each parliamentarian on SSM was sourced from Australian Marriage Equality (2019). Australian Marriage Equality are an advocacy group in favor of marriage equality that developed a website that listed members of parliament, their known public position on SSM, and their contact details as part of their campaign related to the national survey. Positions on SSM were classified as either Supporter, Opposed or Unknown. Of the 231 parliamentarians included in the speech database, 136 were listed as being Supporters of SSM, 55 as being opposed, 35 as unknown and 5 were not listed. The unlisted parliamentarians delivered speeches between 2014 and 2017 but were not included in Australian Marriage Equality's database because they were not in parliament at the time of the national survey.

Additional data on each member of parliament was sourced from the everypolitician dataset available on github. This data provided information including the gender, wikipedia page, picture, email address and twitter account for politicians (mySociety Limited, 2018).

Data on electoral outcomes at the electorate level was soured from the Australian Broadcasting Corporation (2019). This includes the state in which each electorate is located, the winning party in each election for each electorate for the years 2001-2016 and the margin of victory in that electorate for that party in that year.

We merged the data on the results of the national survey and the electoral outcomes using the electorate's name because the data is all at the electorate level. Data from Hansard, Australian Marriage Equality and everypolitician are at the politician level and were merged using the unique politician code listed in Hansard files. As each politician represents a single electorate or state, the combined electorate level and politician level datasets could then be merged by a concordance between the politician and the region that they represent. This means that, for every speech delivered, detailed data is available about the person who delivered the speech and their political circumstances.

The steps for turning the speeches into data involved reformatting and tidying the text, refining the corpus into speeches relating to SSM and generating a document term matrix.

The approximately 60,000 speeches delivered over 2014-2017 were cleansed using a number of steps as outlined in (Gentzkow et al., 2019b). Initial cleansing steps involved conversion to lower case, removal of punctuation marks and other symbols and trimming excess whitespace. All stop words based on a database compiled by Silge & Robinson (2016) were then removed. Geographic place names sourced from Mittaz (2009) were also removed. A Porter Stemmer was then applied to reduce inflections and retain the root of each word (Meyer et al., 2008). These steps produce a filtered version of the raw speech data, similar to that shown below.

Before Cleansing

"I'm very proud to report that in the recent marriage equality survey 81 per cent of people in Kingsford Smith participated, and 64.1 per cent voted yes in favour of marriage equality; that is above the national average. I'm honoured to be here today to represent our community's voice on this very important issue, and to cast my vote in favour of marriage equality."

After Cleansing

"proud report recent marriag equal survei cent peopl smith particip cent vote favour marriag equal nation averag honour repres commun voic issu cast vote favour marriag equal"

The set of speeches was then significantly reduced to focus only on those that contained phrases related to SSM. To identify phrases related to SSM, first, all speeches that contained the word "marriage" during the time period from 24 October to 7 December 2017 were flagged as being likely related to SSM. A log-odds ratio was then calculated to identify which phrases were most distinctively used when discussing SSM. The top 280, approximately, phrases most associated with SSM related speeches were then used to narrow the broader corpus of 60,000 speeches down to those likely relating to SSM – any speech containing one of the approximately 280 phrases was identified as a SSM related speech[6]. As an example, the top 10 highest scoring phrases that indicated a speech related to SSM are shown in Table 2.2 with a full listing of phrases provided in Appendix D. This process reduced the total number of speeches in the corpus to 3216.

Finally, a document term matrix (denoted **X**) was generated. Bigrams were compiled for each speech by merging each ordered pair of words into a single language token. This would mean that the above speech was represented as a set of language tokens "proud.report", "report.recent", "recent.marriag" and so on.

The number of unique bigrams in the SSM related speeches was reduced to focus on the

[6] Some administrative speeches given by the Speaker of the House were also removed.

Table 2.2: Bigrams most indicative of a SSM related speech

Rank	SSM Bigram
1	"marriag equal"
2	"sex marriag"
3	"marriag amend"
4	"freedom bill"
5	"amend definit"
6	"definit religi"
7	"support marriag"
8	"definit marriag"
9	"postal survei"
10	"marriag celebr"

Source: Author's calculations

roughly 280 bigrams that are most likely to convey information about SSM. The presence of these bigrams was represented in a matrix where each cell ($\mathbf{X}_{ij}$) in the matrix indicates the share of that bigram among the SSM related bigrams (j) used in the speech (i). This document term matrix, $\mathbf{X}$, is the summary of the parliamentary speeches that is used in the following analysis.

2.4 Assigning scores to speeches

The next step in the analysis involves using a LASSO model to assign a score to each speech according to how likely the speech was to have been delivered by a Supporter of SSM. The dependent variable in the model was constructed as a vector Y where $Y_i = 1$ if the speaker of speech i was a known Supporter of SSM and $Y_i = 0$ if the speaker was a known Opposer of SSM according to Australian Marriage Equality (2019). The independent variable was the document term matrix, $\mathbf{X}$, developed through the process described in the previous section. Within the LASSO model, a negative binomial log-likelihood objective function was used to reflect the fact that the underlying dependent variable is a binary variable. The value for the regularization parameter, λ, was selected by cross validation using 10 folds in the data and selecting the model using the area under the curve method.

The LASSO model selected non-zero coefficients for around 60 bigrams. A negative coeffi-

Table 2.3: Large Magnitude Lasso Coefficients

Example Negative Coefficient	Example Positive Coefficient
1) express act	1) religi marriag
2) freedom parent	2) support marriag
3) express associ	3) marriag equal
4) tradit definit	4) conform doctrin
5) conscienc freedom	5) lgbti australian

Note: Bigrams with negative coefficient are associated with Opposers of SSM while bigrams with positive coefficients are associated with Supporters of SSM. The bigrams are ordered by magnitude.
Source: Author's calculations

cient estimate for a bigram indicates that it is associated with use by an Opposer of SSM while a positive coefficient is associated with use by a Supporter of SSM. The top bigrams with large parameter estimates (both positive and negative) are presented in Table 2.3. The first column shows phrases with negative coefficients, which are phrases that are most likely to be used by Opposers of SSM. Phrases here tend to focus on concepts of religious freedoms and traditional marriage. The next column shows phrases with positive coefficients, which are most likely to be used by Supporters of SSM. These phrases tend to focus on support for marriage equality and LGBT issues. A full listing of non-zero coefficients and bigrams is presented in Appendix E.

A predicted value for each speech was calculated using the parameter estimates from the LASSO model. The predicted value lies between 0 and 1 and should be interpreted with 0 as a speech that is perfectly informative of an Opposer while a value of 1 indicates a speech that is perfectly informative of a Supporter.

The speech with the lowest predicted value was delivered by Tony Pasin (LNP) in June 2015 (score of 0.01) and contained phrases such as "...would not support a change to legislation on the issue of same sex marriage..." as well as the specific phrase "traditional definition" that appears in Table 2.3. The speech with the highest predicted value was delivered by Cathy O'Toole in September 2016 (score of 0.99) and generally focuses on the need to protect underprivileged groups including statements such as "[I am] grounded in human rights and social justice ... ensuring that all people at every level within our communities experience a fair

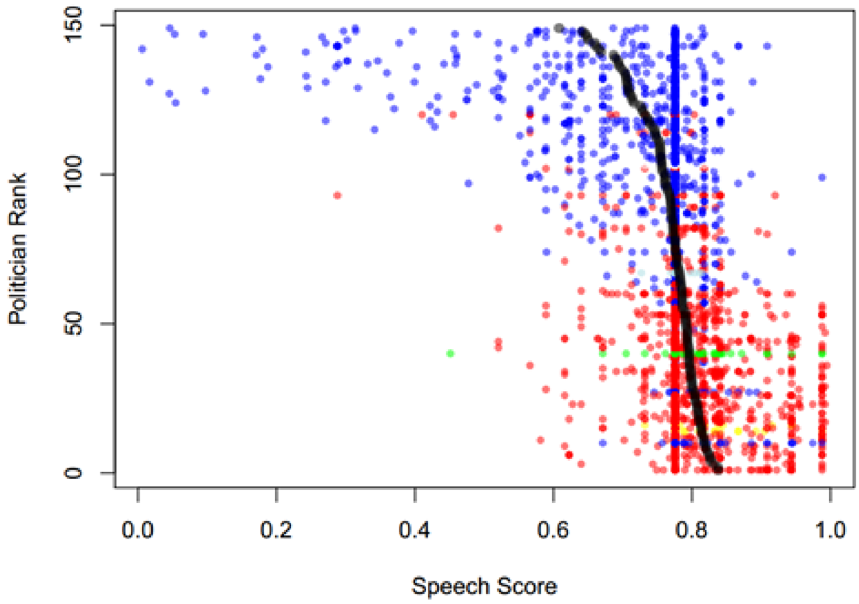


Figure 2.2: Predicted Speech Scores Sorted by Average for Each Speaker

Note: Each row of dots represents a different politician with blue dots indicating members of the LNP, red dots members of the ALP and green dots members of the Greens. Black dots show the average position of the speaker. A speech score of 0 indicates a speech that is perfectly informative of opposition to SSM while a score of 1 indicates a speech that is perfectly informative of support for SSM.
Source: Author's Calculations

go..."

These predicted values allow for the position of each speech by each Member of Parliament to be analyzed. Figure 2.2 shows that speeches delivered by members of Labor (shown as red dots) and The Australian Greens (green dots) are often estimated to be indicative of support for SSM while speeches delivered by LNP representatives (blue dots) tend to be less supportive of SSM. There are, however, some clear exceptions to this general rule, indincating that the position of candidates on this issue isn't perfectly aligned with party affiliation. The results also indicate that, for each speaker, there is significant variation in speech scores.

It is also possible to analyze predicted values over time for each state and party. The average speech score for 2017 is shown in Figure 2.3. Generally, the ACT and Tasmania are estimated to be the most strongly aligned with support for SSM while Queensland and NSW are estimated to be most closely aligned with opposition to SSM. The average speech score for each party shows that the Greens, ALP and Independents are strong Supporters of SSM while the LNP and Katter's Australia Party (KAP) are strong Opposers.

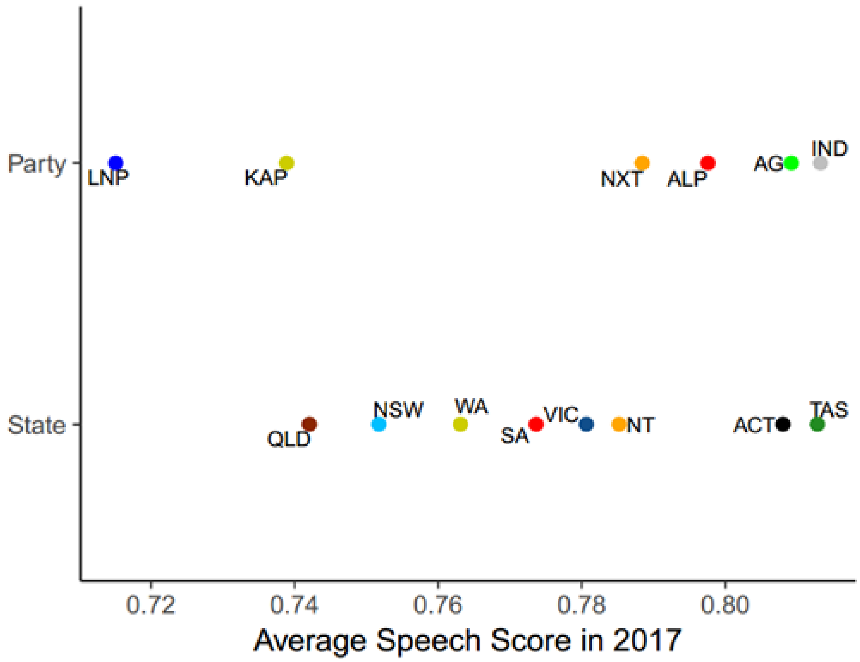


Figure 2.3: Predicted Speech Scores Sorted by Average for Each Party and State

Note: Each dot represents the average speech score for in 2017 for a particular group. The upper row of dots groups by political party with LNP indicating Liberal National Coalition, KAP indicating Katter's Australia Party, NXT indicating the Nick Xenophon Team, ALP indicating the Australian Labor Party, AG indicating the Australian Greens and IND indicating independents. The lower row of dots indicates the average speech score for representatives from different states.
Source: Author's Calculations

Plotting the fitted values of speech scores over time (Figure 2.4) indicates that there is no practically relevant time trend in speech scores over the period from 2014-2017 (the fitted line is a quadratic function of time). An important feature is the large number of speeches relevant to SSM delivered in December 2017 following the release of the SSM national survey. Many of the speeches delivered in that time period have low speech scores, indicating likely opposition to SSM.

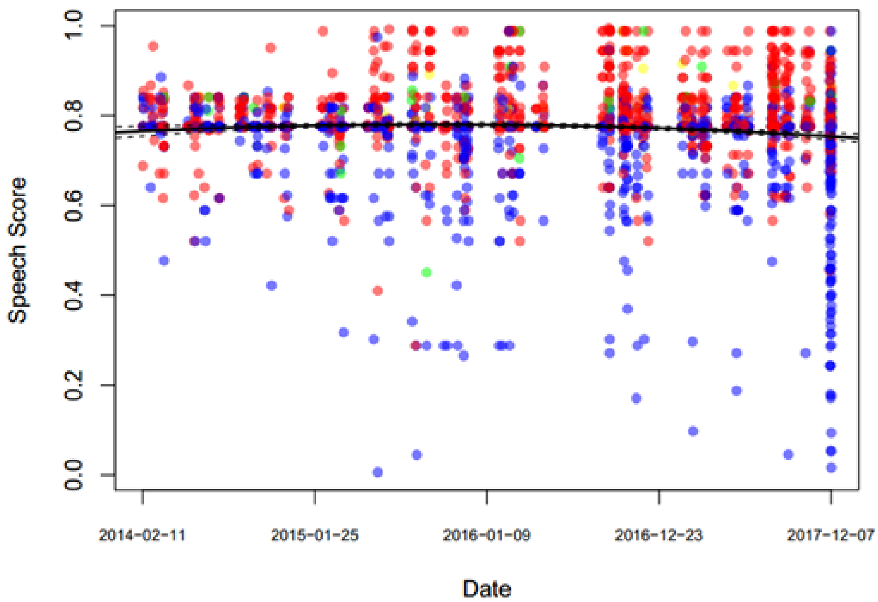


Figure 2.4: Predicted Speech Scores Over Time

Note: Each dot represents a speech delivered by a member of the House of Representatives with blue dots indicating members of the LNP, red dots members of the ALP and green dots members of the Greens. The black line is a quadratic time trend with 95% confidence interval. A speech score of 0 indicates a speech that is perfectly informative of opposition to SSM while a score of 1 indicates a speech that is perfectly informative of support for SSM.
Source: Author's Calculations

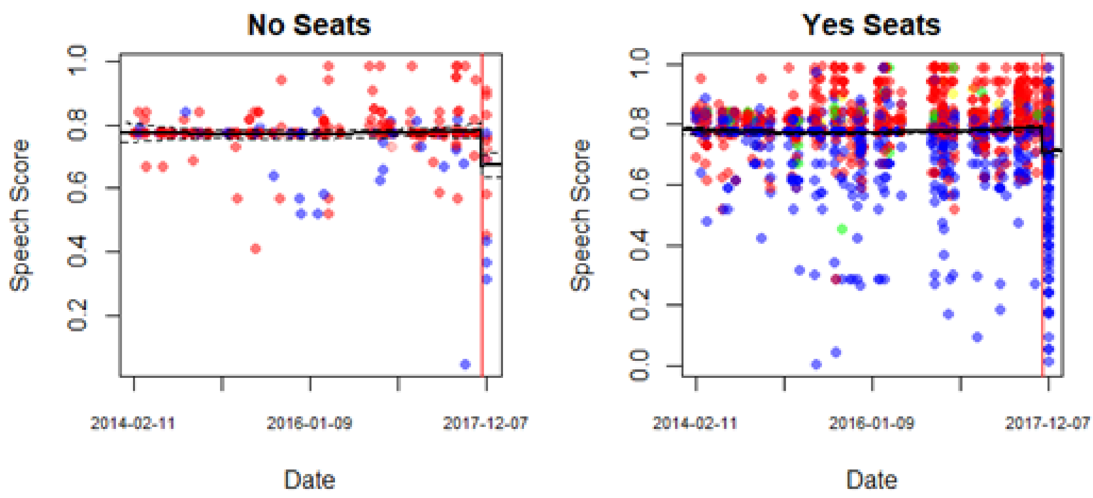


Figure 2.5: Predicted Speech Scores Grouped by Result

Note: Each dot represents a speech delivered by a member of the House of Representatives with blue dots indicating members of the LNP, red dots members of the ALP and green dots members of the Greens. The black line is a quadratic time trend with 95% confidence interval. The vertical red line indicates the release of the SSM survey results. A speech score of 0 indicates a speech that is perfectly informative of opposition to SSM while a score of 1 indicates a speech that is perfectly informative of support for SSM.
Source: Author's Calculations

2.5 Estimating changes in speech scores

2.5.1 Graphical analysis

Graphical analysis provides a basic approach to investigating how behavior changed after the release of the national SSM survey results . Figure 2.5 splits the overall sample into two groups, seats where the majority voted against SSM (No seats) and seats where the majority voted in favor of SSM (Yes seats). Visually, for Both Yes and No seats, there appears to be a downward shift following the announcement of SSM results. This shift is statistically significant for both types of seats. The average downward shift in both cases is similar in magnitude but slightly larger in No seats.

Figure 2.6 shows a similar analysis for representatives who are known Supporters and Opposers of SSM. There are clear differences between the two groups: Supporters do not appear to change their position significantly (the change is not statistically significant at conventional levels) while the speech scores for Opposers reduce notably (the change is highly statistically significant).

These initial results provide some indication that the position of the electorate may not have

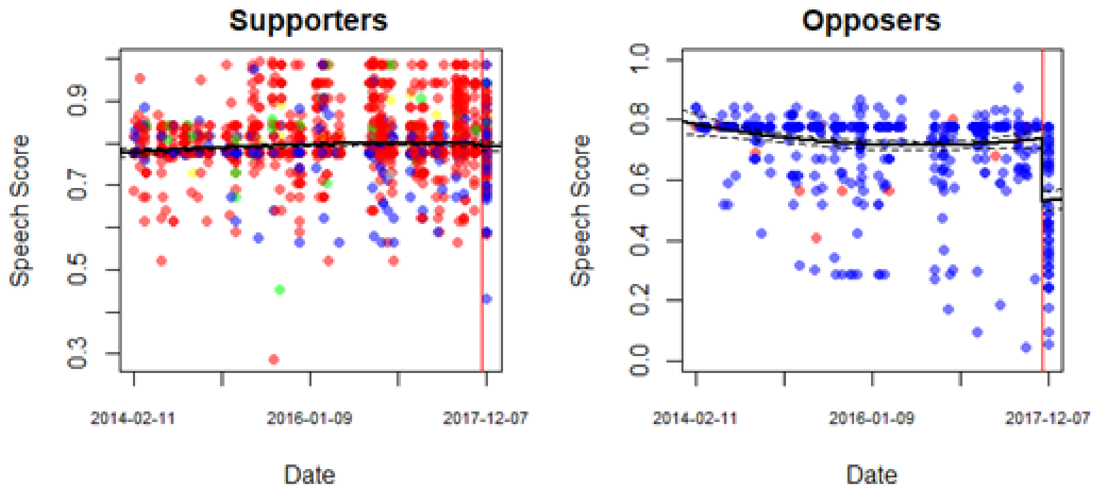


Figure 2.6: Predicted Speech Scores Grouped by Known Position on SSM

Note: Each dot represents a speech delivered by a member of the House of Representatives with blue dots indicating members of the LNP, red dots members of the ALP and green dots members of the Greens. The black line is a quadratic time trend with 95% confidence interval. The vertical red line indicates the release of the SSM survey results. A speech score of 0 indicates a speech that is perfectly informative of opposition to SSM while a score of 1 indicates a speech that is perfectly informative of support for SSM.
Source: Author's Calculations

had a strong influence on politician's behavior when debating the SSM legislation but that personal ideology plays a role.

These results can be further broken down by looking at the difference in behavior between Supporters and Opposers of SSM within each type of electorate. Figure 2.7 shows these results. After disaggregating these groups, it appears that Opposers saw decreases in their speech scores during the debates over SSM legislation, occurring regardless of whether their electorate voted majority in favor or majority opposed to SSM. For Supporters, those in electorates that voted majority opposed to SSM saw a small but not statistically significant decrease in speech scores while Supporters in electorates that voted majority Yes saw essentially no change in speech scores.

Analysis of the underlying speech patterns that determine this behavior provides some further insight into what is causing the change in speech scores. Figure 2.8 shows the frequency of use of bigrams with non-zero coefficients from the LASSO model. The bigrams have been sorted from smallest to largest so that bigrams on the left-hand side are associated with opposition to SSM, while bigrams on the right-hand side are associated with support for SSM. Following the release of the SSM survey results, Supporters of SSM used more phrases that are associ-

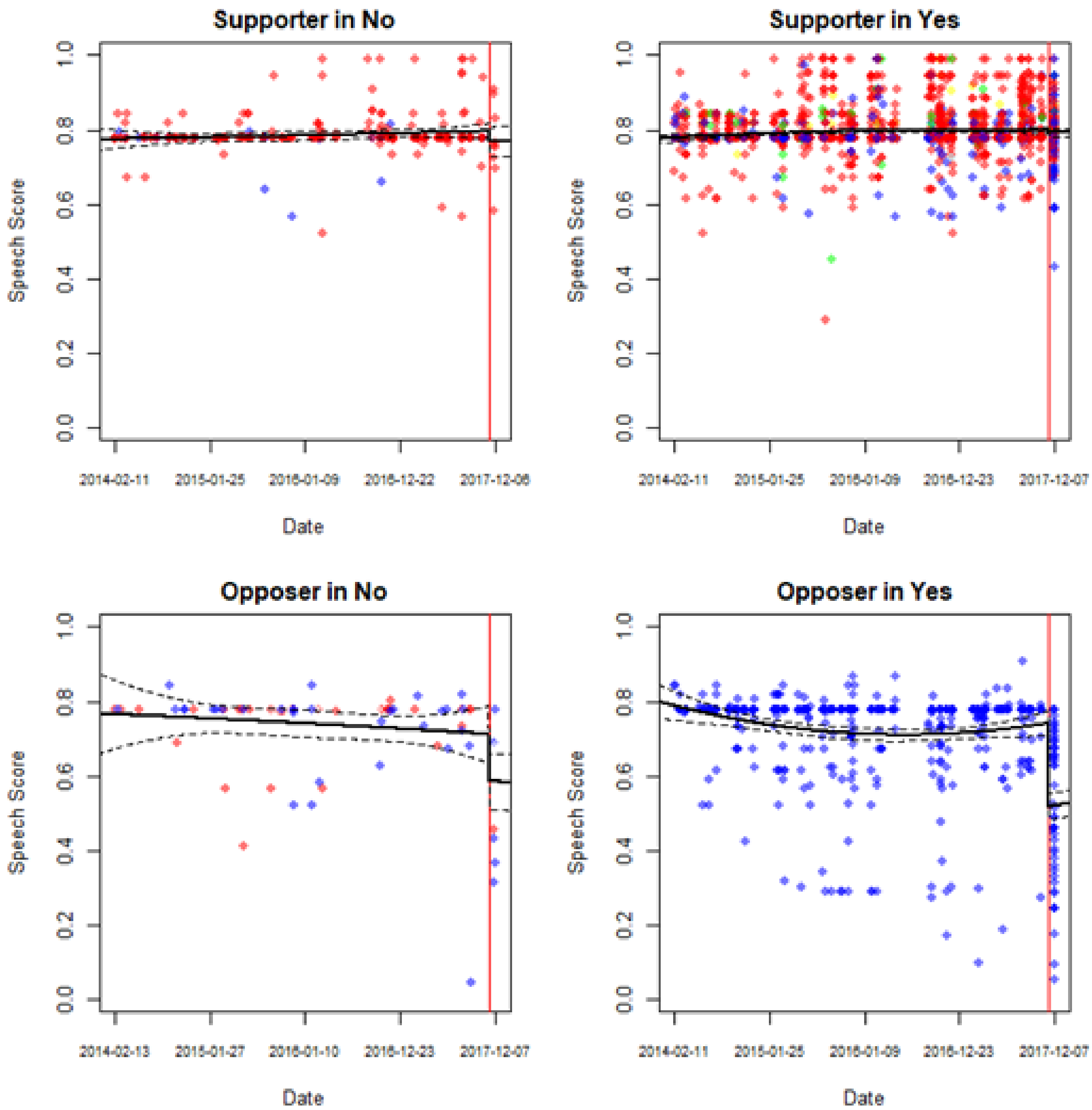


Figure 2.7: Predicted Speech Scores Grouped by Result and Known Position

Note: Each dot represents a speech delivered by a member of the House of Representatives with blue dots indicating members of the LNP, red dots members of the ALP and green dots members of the Greens. The black line is a quadratic time trend with 95% confidence interval. The vertical red line indicates the release of the SSM survey results. A speech score of 0 indicates a speech that is perfectly informative of opposition to SSM while a score of 1 indicates a speech that is perfectly informative of support for SSM.
Source: Author's Calculations

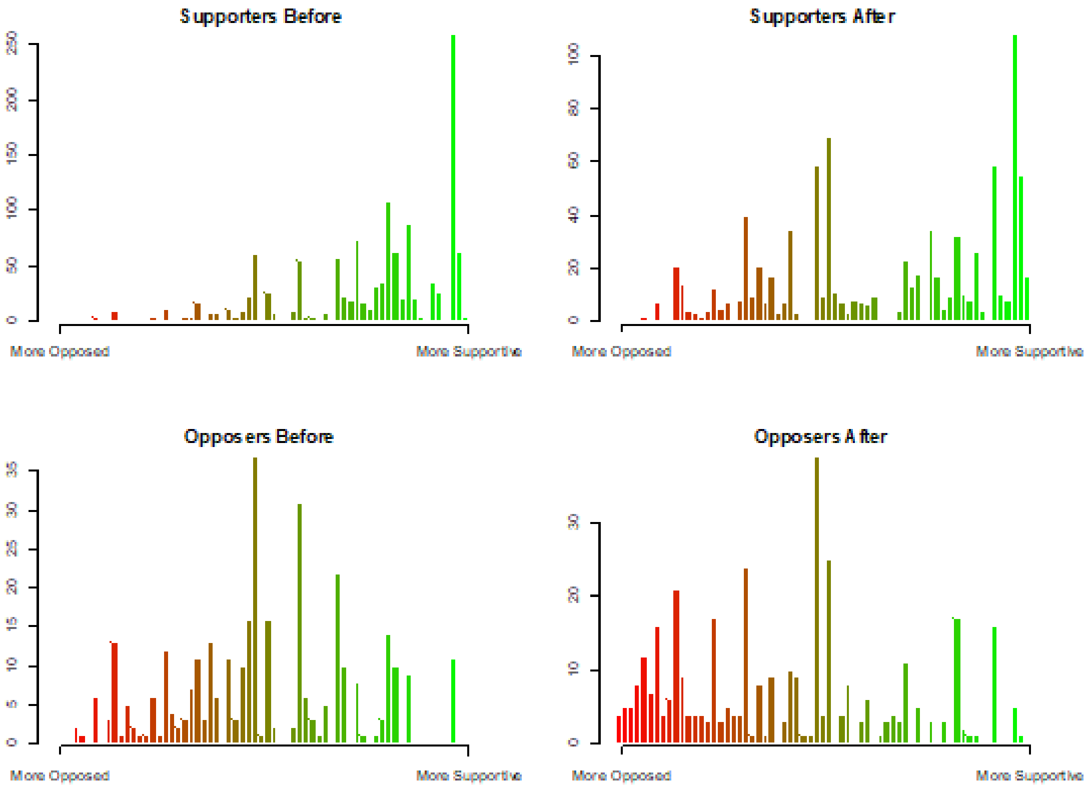


Figure 2.8: Frequency of use of Phrases by Supporters and Opposers of SSM Before and After the National Survey Results are Released

Note: Each bar represents a bigram with the bigrams ordered from most indicative of opposition to SSM on the left to most indicative of support for SSM on the right. The bigrams in each panel are the same and in the same order.
Source: Author's Calculations

ated with opposition to SSM as well as more neutral phrases, but they mostly continued to strongly use phrases that indicate support for SSM. For Opposers, before the release of the SSM survey results, there is frequent use of somewhat supportive phrases. After the results are released, this use of somewhat supportive phrases reduces and there is an increase in the use of phrases that indicate strong opposition to SSM. Within the context of the previous results, this explains the reduction in speech scores for Opposers and also means that this change in speech patterns applies for Opposers regardless of how their electorate voted in the SSM national survey.

Although providing some insight, these graphical analyses are not sufficient to determine whether or not these effects are genuine. For example, the patterns seen could be driven by differences in the composition of speakers before and after the SSM survey results are released. Controlling for these and other factors is critical and is addressed in the following section.

2.5.2 Main results

This section presents an econometric analysis that formalizes the graphical analysis in the previous section. As the underlying speech scores are time series observations for each representative in parliament, I am able to use individual level fixed effects to control for time-invariant observable and unobservable factors as well as including a time-based control. The results in this section therefore present models of the form:

$$\begin{aligned} S_{it} = \beta_1 \left(after_t * Supporter.in.No_i\right) + \beta_2 \left(after_t * Opposer.in.No_i\right) \\ +\beta_3 \left(after_t * Opposer.in.Yes\right) + \beta_4 \left(after_t * Supporter.in.Yes\right) \\ +\partial_i + f(t) + \varepsilon_{it}, \end{aligned} \tag{2.2}$$

where S_{it} is the Speech Score derived from a speech delivered by representative i at time t, $after_t$ is a dummy variable equal to 1 if the speech is delivered after the announcement of the national survey results, $Supporter.in.No_i$ is a dummy variable equal to 1 if i is a Supporter of SSM[7] in an electorate that voted majority No in the national survey (other variables are similarly defined), ∂_i are individual fixed effects and $f(t)$ are controls for time-based effects. With this specification, β_1 through β_4 will show how each group responded during the period of debate over SSM legislation.

Given the structure of the data, there is some flexibility on the approach to controlling for time-based effects. The results presented in Table 3.4 show two variations: Column 1 includes fixed effects for year while Column 2 includes a second order polynomial of time interacted with each category of representative. The approach in Column 1 is the preferred specification with Column 2 used as a robustness check and as a point of reference against the graphical analysis as it essentially replicates the same approach.

The results in Table 3.4 show a clear pattern where Supporters of SSM do not appear to change their behavior while Opposers of SSM do change their behavior – as was seen in the

[7] As defined by Australian Marriage Equality (2019).

Table 2.4: Main Results – Speech Score

	Dependent variable:	
	Speech Score	
	(1)	(2)
Supporter in No	−0.018	−0.024
	(0.042)	(0.042)
Opposer in No	−0.150***	−0.154***
	(0.043)	(0.056)
Opposer in Yes	−0.206***	−0.227***
	(0.033)	(0.044)
Supporter in Yes	0.007	−0.0004
	(0.008)	(0.009)
Year FE	Yes	
Date polynomial		Yes
Observations	3,138	3,138
R^2	0.088	0.109

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the speaker level. Column 1 shows the results using year fixed effects while Column 2 shows results using a second order polynomial of time interacted with each category of representative. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

graphical analysis. For Supporters of SSM there is no statistically significant change in their support ($\beta_1, \beta_4 \approx 0$ and not statistically significant). Opposers of SSM become stronger in their opposition after the results of the SSM national survey are released and during debate in parliament on the legislation ($\beta_2, \beta_3 \leq 0$). The parameter estimates for Opposers are highly statistically significant and are also fairly consistent across the two approaches to controlling for time-based effects. The effect on Opposers is also similar regardless of the electorate's vote; in fact, representatives in electorates that voted majority Yes appear to react more strongly than representatives in electorates that voted majority No, although there is significant overlap in confidence intervals. This suggests that personal ideology, not the position of the electorate determined the response of politicians.

2.5.3 Robustness checks

There is the possibility that the results above are sensitive to choices made during the text processing and text regression. For example, a choice was made to use bigrams (as compared to trigrams, for example) and also to calculate the document term matrix as a share. Reproducing the analysis above using trigrams gives the results shown in Table 2.5. It should be noted that the sample size changes in this case as the use of trigrams means that a different, and smaller, set of speeches are flagged as SSM related speeches.

For Opposers of SSM, these results are similar in nature to those reported above with negative and generally statistically significant parameter estimates. The results for Supporters, in Column 1 of Table 2.5 which uses year fixed effects, are notably different. The parameter estimates for Supporters are positive and statistically significant. This provides some evidence that Supporters may have become stronger in their support following the release of the SSM national survey results. However, these results do not translate into Column 2, which uses a polynomial to control for time-based effects. This robustness check confirms that the decision to use bigrams does not determine the main results for Opposers.

Similarly, reproducing the analysis above but using a document term matrix that is based on an indicator for the presence of a bigram, rather than the share, produces the results shown in

Table 2.5: Robustness Check - Speech Score Using Trigrams

	Dependent variable:	
	Speech Score	
	(1)	(2)
Supporter in No	0.115***	0.086
	(0.038)	(0.080)
Opposer in No	−0.316**	−0.275
	(0.125)	(0.171)
Opposer in Yes	−0.445***	−0.388***
	(0.057)	(0.135)
Supporter in Yes	0.061***	0.034
	(0.019)	(0.021)
Year FE	Yes	
Date polynomial		Yes
Observations	839	839
R^2	0.226	0.274

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the speaker level. Column 1 shows the results using year fixed effects while Column 2 shows results using a second order polynomial of time interacted with each category of representative. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

Table 2.6.[8]

Table 2.6: Robustness Check - Speech Score Using Indicator Variables in Document Term Matrix

	Dependent variable:	
	Speech Score	
	(1)	(2)
Supporter in No	0.139***	0.138***
	(0.031)	(0.034)
Opposer in No	−0.294***	−0.295***
	(0.090)	(0.089)
Opposer in Yes	−0.393***	−0.405***
	(0.029)	(0.038)
Supporter in Yes	0.094***	0.082***
	(0.014)	(0.016)
Year FE	Yes	
Date polynomial		Yes
Observations	3,138	3,138
R^2	0.220	0.241

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the speaker level. Column 1 shows the results using year fixed effects while Column 2 shows results using a second order polynomial of time interacted with each category of representative. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

These results are similar to the main results as Opposers of SSM are found to become more opposed. As in the trigrams robustness check there is also evidence here that Supporters become more supportive and that this result holds across different approaches to controlling for time-based effects. This confirms that the decision on the DTM does not determine the main results for Opposers. The findings here may be because a DTM based on indicator variables means that, when more phrases related to SSM are used, the estimated speech score is likely to become more extreme and, thus, apparent changes in the speech score are more easily measured. In this case, a DTM based on an indicator variable may be creating an over-fitting type effect within the LASSO model, while a DTM based on the share of bigrams provides a more conservative approach to the analysis.

[8] Each cell (X_{ij})in the matrix is either a 0 or 1 with a 1 indicating the presence of bigram j in speech i.

Another potential concern with the main results is that each speech is given the same weight in the regression. Even though steps were taken to focus on speeches related to SSM, the remaining speeches will still vary in their relevance to the topic of SSM. Equally weighting each speech may give speeches with more focus on SSM less weight in the results than is warranted. To address this, the results below present a weighted least squares estimation where each speech is given a weight based on the number of SSM bigrams used in the speech. Overall, the results are fairly similar to the main results. For the results shown in Table 2.8, both the parameter estimates and their standard errors are very similar to those in the main results. The robustness of findings here suggests that the initial process for identifying speeches is reliable and that the main results are not being driven by noisy changes in speeches only vaguely related to SSM.

Table 2.7: Robustness Check - Speech Score Using Weighted OLS

	Dependent variable:	
	Speech Score	
	(1)	(2)
Supporter in No	−0.037	−0.064
	(0.033)	(0.047)
Opposer in No	-0.190^{**}	−0.069
	(0.076)	(0.183)
Opposer in Yes	-0.167^{***}	-0.179^{***}
	(0.039)	(0.044)
Supporter in Yes	−0.009	-0.036^{***}
	(0.009)	(0.009)
Year FE	Yes	
Date polynomial		Yes
Observations	3,138	3,138
R^2	0.165	0.216

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the speaker level. Column 1 shows the results using year fixed effects while Column 2 shows results using a second order polynomial of time interacted with each category of representative. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

The small number of representatives and the strong spread in ideological positions could also

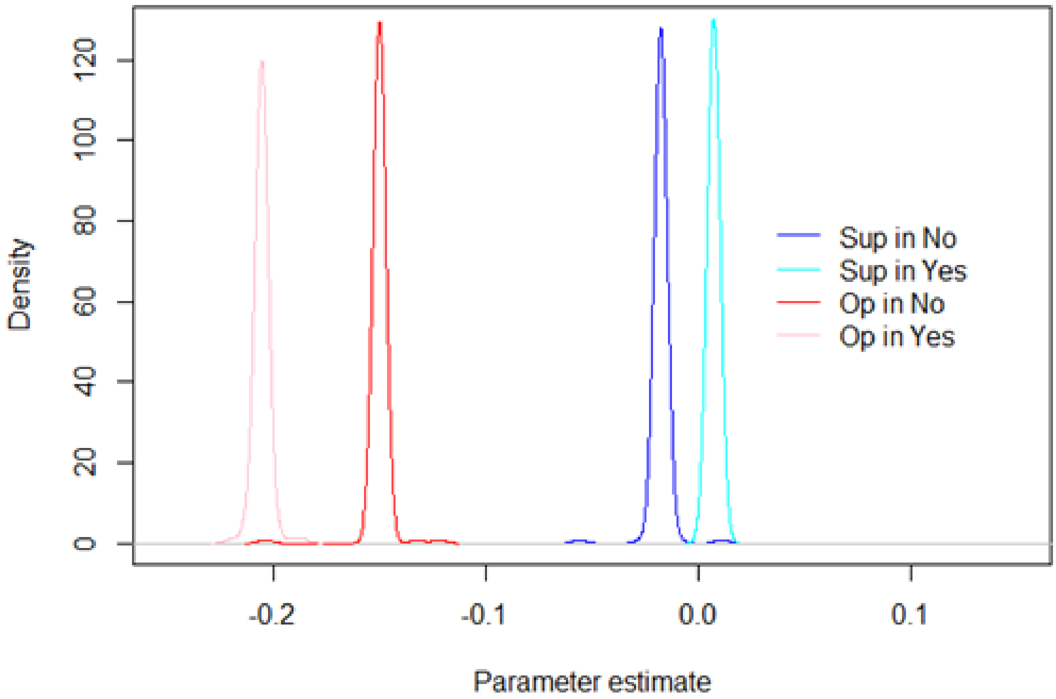


Figure 2.9: Robustness Check - Jack-knife - Speech Score

Note: Each kernel density estimate represents the range of parameter estimates found when conducting an iterative leave-one-out estimation procedure.
Source: Author's Calculations

be a source of noise in the data. It's possible that the results presented above are being driven by a small number of extreme observations. To test this, Figure 2.9 presents the results of a jack-knife approach where the main model was repeatedly estimated on samples that sequentially excluded a single representative. Although there is some variability in the estimated parameter value, overall, the parameters are tightly grouped around the parameter estimates reported above. This suggests that the main results are not being driven by a small number of extreme observations.

A placebo test is also possible using an outcome – number of words in the speech – that isn't expected to be related to SSM. Applying an identical approach to that used in the main results generates the results in Table 8. Most parameter estimates are found to be not statistically significantly different from zero, although Supporters in Yes seats do appear to give shorter speeches after the release of the SSM national survey results. The explanatory power of this model is also far lower than in the main results, and there is no systematic relationship between the sign of the parameter estimate and the ideological position of the representative.

This placebo test generally confirms that the main results are likely to be a genuine effect resulting from behavior change of elected representatives.

Table 2.8: Robustness Check - Placebo Test - Speech Length

	Dependent variable:	
	Speech Length	
	(1)	(2)
Supporter in No	111.643	98.077
	(79.529)	(120.194)
Opposer in No	37.951	63.032
	(77.771)	(70.938)
Opposer in Yes	79.141	102.541
	(82.027)	(96.767)
Supporter in Yes	-94.587^{***}	-70.778^{*}
	(22.020)	(37.621)
Year FE	Yes	
Date polynomial		Yes
Observations	3,138	3,138
R^2	0.013	0.013

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the speaker level. Column 1 shows the results using year fixed effects while Column 2 shows results using a second order polynomial of time interacted with each category of representative. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

A final robustness check, in Tables 2.9 and 2.10, is based on splitting the sample into three groups according to the percentage of "Yes" votes in the national survey, ranging from low levels of support for SSM to high levels of support. There are no parameter estimates for the 'Supporter in No' and 'Opposer in No' groups in Columns 2 or 3 of both tables because these subgroups do not have any electorates that voted majority "No". The results are similar to the main results, particularly for 'Opposers in Yes' seats where the parameter estimate is consistently negative and statistically significant for all groups. The results are also similar for the year fixed effect and time polynomial approaches. This robustness check indicates that the results aren't being driven by a single group within the data.

Table 2.9: Subgroup analysis - Group by "Yes" Percentage - Year Fixed Effects

	Dependent variable:		
	Speech Score		
	(1)	(2)	(3)
	Low Support	Mid Support	High Support
Supporter in No	−0.014		
	(0.043)		
Opposer in No	−0.146***		
	(0.043)		
Opposer in Yes	−0.188***	−0.130***	−0.304***
	(0.040)	(0.038)	(0.067)
Supporter in Yes	0.025***	0.014	−0.004
	(0.010)	(0.014)	(0.011)
Year FE	Yes	Yes	Yes
Mean "Yes" Percentage	49.9%	62.0%	73.2%
Observations	952	1,058	1,128
R^2	0.113	0.035	0.119

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the speaker level. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

Table 2.10: Subgroup analysis - Group by "Yes" Percentage - Date Polynomial

	Dependent variable:		
	Speech Score		
	(1)	(2)	(3)
	Low Support	Mid Support	High Support
Supporter in No	−0.024		
	(0.043)		
Opposer in No	-0.154^{***}		
	(0.057)		
Opposer in Yes	-0.200^{***}	-0.171^{***}	-0.327^{**}
	(0.048)	(0.045)	(0.144)
Supporter in Yes	0.037^{***}	−0.0002	−0.009
	(0.011)	(0.015)	(0.012)
Date polynomial	Yes	Yes	Yes
Mean "Yes" Percentage	49.9%	62.0%	73.2%
Observations	952	1,058	1,128
R^2	0.151	0.059	0.139

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the speaker level. *p<0.1; **p<0.05; ***p<0.01

Overall, across the range of robustness tests applied, the same main results are seen: Opposers become more opposed regardless of how their electorate voted. There is generally not a consistent, statistically significant response from Supporters. However, some of the robustness tests show evidence that an effect is present for Supporters that was not seen in the main results where they become more supportive regardless of how their electorate voted on SSM. If this effect is taken as genuine, then it is possible that the role of personal ideology could be higher than indicated by the main results.

2.5.4 Individual results

The structure of the data, where there are multiple speeches given by each representative over time, also allows for analysis of individual responses to the SSM national survey results. Analysis at the individual level provides insight on the heterogeneity of effects within the groups identified above. The results in this section are based on models of the form:

$$S_{it} = \beta_1^i\,(after_t * \delta_i) + \delta_i + f(t) + \varepsilon_{it}, \tag{2.3}$$

where S_{it} is the Speech Score derived from a speech delivered by representative i at time t, $after_t$ is a dummy variable equal to 1 if the speech is delivered after the announcement of the national survey results, δ_i are individual fixed effects and $f(t)$ are controls for time period (in this section, the analysis is restricted to year fixed effects). With this specification, β_1^i gives the change in the outcome variable for individual i after the release of the SSM national survey results.

Figure 2.10 shows a plot of each β_1^i, and a 95% confidence interval, grouped into the same categories used in the earlier analysis. Within each group there is meaningful heterogeneity. For example, the "Supporter in Yes" group did not have a statistically significant coefficient in the main results but there are individuals with both positive and negative point estimates of β_1^i. The point estimates for almost all Supporters are, however, not statistically significantly different from zero at the 5% level of significance –- confirming the main results. The majority of Opposers, are estimated to have reductions in their speech score that are statistically significantly different from zero at the 5% level of significance. This finding for Opposers is true regardless of the position of their electorate and the largest negative change in speech score is actually seen among representatives in seats that voted majority Yes.

Further regressions on the individual β_1^i variables, which are reported in Table 2.11, do not indicate that observable characteristics such as party, gender, tenure or margin in previous elections have explanatory power for the estimated value of β_1^i. This suggests that differences in individual level responses are likely driven by unobservable characteristics such as personal beliefs.

These individual level results show that, while there is heterogeneity among politicians, almost all Opposers are found to become more opposed while almost all Supporters are found to not change their speech score by a statistically significant amount. This result cannot be explained by observable characteristics of the representatives – their party, gender, tenure or electoral security – and, thus, are likely to depend on unobservable characteristics, such as personal beliefs. The results at the individual level support the main empirical and theoretical findings but do show considerable heterogeneity between individuals.

2.6 Conclusion

The analysis in this paper indicates that, in this case at least, personal ideology, not the position of the electorate, plays a large role in determining political speech. In particular, Opposers of SSM tended to become stronger in their opposition to SSM once the results of the SSM national survey were released – the average Opposer increased their opposition by 0.15-0.2 on a scale of 0-1. This strengthening of opposition occurred regardless of the position of their electorate. No consistent and statistically significant change is seen in the behavior of Supporters of SSM. Further, the fact that the observed positions of Supporters and Opposers of SSM moved apart indicates that polarization did take place.

The results align with an emerging consensus in empirical literature such as Lee (2008), Al-

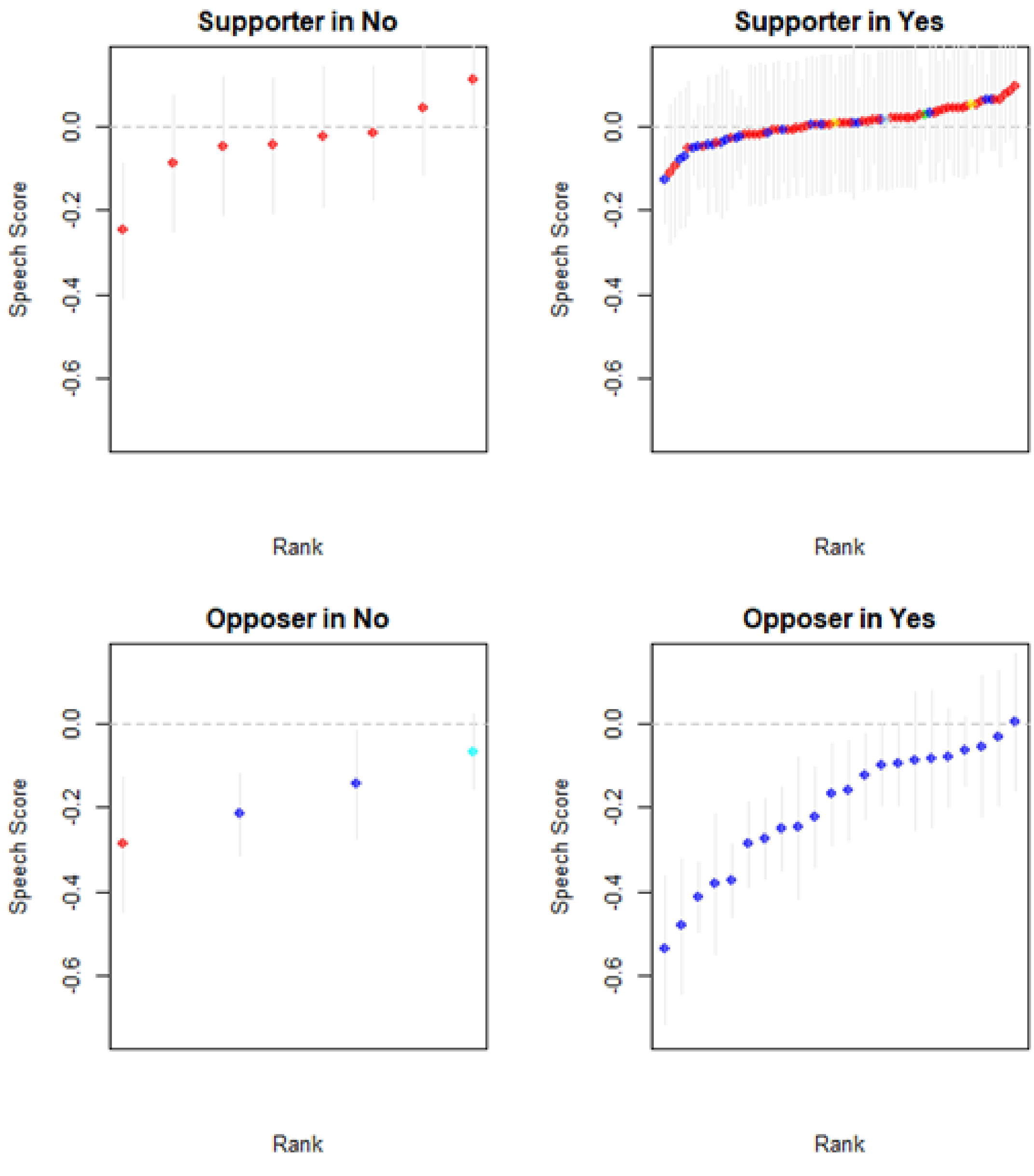


Figure 2.10: Individual Level Results - Speech Score

Note: Each dot represents a member of the House of Representatives with blue dots indicating members of the LNP, red dots members of the ALP and green dots members of the Greens. The grey lines show 95% confidence intervals. A parameter estimate of 0 indicates a no changes in speech score following the release of the SSM national survey, a negative value indicates speeches becoming more opposed and a positive value indicates speeches becoming more supportive of SSM.
Source: Author's Calculations

Table 2.11: Individual Level Results – Determinants of β_1^i

	Dependent variable:
	β_1^i
Constant	0.060
	(0.151)
Party (ALP)	−0.027
	(0.146)
Party (Independent)	0.018
	(0.168)
Party (KAP)	−0.083
	(0.191)
Party (LNP)	−0.140
	(0.138)
Party (NXT)	−0.052
	(0.201)
Male	−0.033
	(0.029)
Tenure (1 election)	−0.072
	(0.067)
Tenure (2 elections)	−0.027
	(0.059)
Tenure (3 elections)	−0.076
	(0.054)
Tenure (4 elections)	−0.016
	(0.088)
Tenure (5+ elections)	−0.028
	(0.047)
Margin in 2016 (%)	0.001
	(0.002)
Observations	127
Adjusted R^2	0.155

Note: $^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

bouy (2011), and Jones & Walsh (2018), which find less than full policy convergence between politicians and the position of the median voter (known as 'partial convergence'). By using a text-as-data approach, these results extend the findings beyond the area of roll-call-voting, which has been the focus of previous analysis, and into political speech. This is important as Gentzkow et al. (2019b) note that speech and roll-call-voting should not be seen as two different manifestations of a single underlying ideological dimension, but that speech responds to a separate set of incentives and constraints. This finding is in contrast to the median voter theorem and its implication that political representatives converge on the preferred position of the median voter in their electorate (Downs, 1957). It is worth noting that there are likely to be other factors operating in this context that may limit the role of the median voter theorem. In particular, in Australia there is strong party level discipline around voting and so the national result may be more important than the local electorate result.

Further work is required to integrate this behavior into a theoretical model of a rational political actor responding to incentives for re-election. For instance, it is challenging to explain why Opposers strengthened their position regardless of how their electorate voted when better representation of their electorate's position would likely increase their chances of re-election. The theory in Austen-Smith (1990), where debate allows individuals to share their private data for agenda setting rather than to influence final voting, partially aligns with the results of this analysis and may present the best starting point.

The results suggest that the purported 'treatment' offered by a national survey, where different politicians would be exposed to different levels of support or opposition to SSM from their electorate did not actually have any affect. Rather, the actual 'treatment' was created by the overall process of running the survey. It's unclear whether, if the national vote was opposed to SSM, the opposite set of results would have occurred.

These results also have direct practical implications for Australian politics. The national survey on SSM was a costly exercise and, prior to its implementation, there were concerns that the survey: could be divisive; harden people into their previously held positions; would not provide new information, as previous polling indicated that a majority Yes vote was expected;

and that the survey would not bind politicians in their behavior. These results go some way to confirming the legitimacy of these concerns – particularly for conservative politicians who were opposed to SSM.

3

Effect of Instant Run-off Voting on participation and civility

Since the mid-20th century, American elections have almost universally used a First Past The Post (FPTP) system for electing candidates (Douglas, 2014). In this system, the candidate who gets the most votes is elected. There has recently been concerns raised that FPTP elections may adversely affect political equality and fair representation (FairVote, 2019). Moving to an instant run-off vote (IRV) approach[1] – where voters rank multiple candidates and the lowest ranked candidate is iteratively removed until the winner has a majority of votes – has been suggested as a way to address some of the concerns with FPTP.

IRV is not an exotic import to the U.S.; IRV was invented in the U.S. and saw early success at

[1] IRV is also known as Alternative Voting, Ranked Choice Voting and Preferential Voting and is occasionally misnamed Single Transferrable Vote (STV). Strictly, STV refers to a similar approach for multi-member electoral districts. For consistency, IRV is used throughout this paper to avoid any potential confusion with other voting systems.

the start of the 20^{th} Century but essentially died out by mid-Century, this has been attributed to reform movements sponsored by large political parties which preferred plurality systems (Reilly, 2004). Currently, IRV is only used in a small number of municipal elections in the U.S. Internationally, IRV is used in Australia and Ireland as well as for some smaller elections in the U.K. and New Zealand.

In the U.S. the number of municipalities using IRV has grown significantly over the last ten years. Recent success has been seen with the use of IRV being endorsed by The New York Times (2018) and IRV has recently been adopted in New York City for specific elections. Increased use of IRV is also being seen in Canada, although to a lesser extent then in the U.S.[2]

The resurgence is based on a range of expected benefits including: ensuring majority support for elected candidates, reducing costs of running elections, increasing civility between candidates, reducing conflict within the electorate, reducing strategic effects for voters and increasing diversity of candidates and elected representatives[3]. These direct benefits have also been expected to translate into an increase in voter turnout.

The growth in IRV means that there is a need to understand whether the purported benefits are being realized. A sizable literature has developed analyzing the various purported benefits. There is mounting evidence in this literature that IRV has not been living up to expectations in many areas. Voters tend to find IRV more challenging. IRV does not ensure majority support for candidates and seems to not affect the outcome of most elections in a meaningful way. IRV has also not reduced administrative costs. IRV has resulted in more diversity of candidates and elected officials but seems to have done this at the cost of greater racial polarization[3]. These findings are also reflected in the broader economic community as leading economists remain mixed in their view of whether IRV is superior to other methods (IGM Forum, 2018).

This paper seeks to address two particular areas of potential benefit of IRV that are important and which have weak methodologies in the existing literature: increasing turnout and improv-

[2] For example, local elections in Cambridge and Kingston, Ontario will likely change to IRV in 2022.
[3] For detailed references on each of these items see Section 3.2

ing civility. Turnout is clearly important to elections: higher levels of turnout improve the mandate of elected officials and ensure that all parts of the community contribute to political outcomes. Civility has been growing in importance due to the perception that elections are becoming more acrimonious and that this both reduces the time spent discussing matters of substance as well as reducing voters' interest in the election process.

While this paper doesn't focus on the theoretical reasons for the relationship between IRV, turnout and civility, some intuition is possible. Under IRV, voters can vote for their most preferred candidate without worrying about whether their vote will be 'wasted', which could lead to higher turnout. Also, under IRV, negative campaigning could turn voters away from placing a candidate second or third in their ranking and so candidates may use more positive communication styles.[4]

Turnout is a focus because, even at the national level, institutional variables are often regarded as the most powerful determinants of voter turnout; a recent meta-analysis finds that there are relatively few studies that analyze institutional impacts on voter turnout in subnational elections (Cancela & Geys, 2016). This view is supported by McDaniel (2016), Donovan et al. (2016) and McDaniel (2019) who consider that there is a lack of systematic and rigorous analysis of voter turnout in the context of IRV rules and that the findings to-date are mixed. Most existing research indicates that IRV has lowered (or at least had no impact on) turnout and there is evidence that this is particularly true for minority and disadvantaged groups. However, the most sophisticated analyses in this area, most remaining unpublished, tend to use data for many cities and a matched difference-in-differences (DID) approach[3]. This approach is problematic as the common trends assumption is unlikely to hold across the range of cities in the analyses. For example, McDaniel (2019), which is the most recent and thorough of these papers, notes that "visual inspection of the data does suggest that the comparison group

[4]Relying on interviews with candidates, Mauter (2014) generally found that the introduction of IRV helped to create a more inclusive election in 2013 in Minneapolis and that campaigns mostly didn't use negative campaigning. Quoting an interview with candidate Shultz shows some of the logic behind this finding: "For instance where Mark Andrew said about Betsy Hodges, she has the disease of a small vision. I mean that was a big deal. In any other political context, it would have been nothing, but the fact that it was so jarring because it was really one of the only instances we had in the campaign we could point to of actual negativity happening." In addition Mauter notes that campaigns used the word "choice" in asking for support. Campaigns kept in contact with voters identified as supporters of other candidates and made strategic choices in doing so.

election data may present a violation of the parallel trends assumption." Given the likely violation of the common trend assumption, the conclusions from these previous papers may not be reliable. This paper contributes to the literature by focusing on an in-depth analysis of a single metro area, the Minneapolis-St. Paul Metro Area, where the common trends assumption does hold and can be more carefully analyzed.

Civility is a focus because recent advances in econometric technique allow for new approaches to the analysis of speech and text (Gentzkow et al., 2019a). This can provide a more precise quantification of the effect of IRV on civility during campaigns than previous research, which has used surveys or interviews. In terms of civility, previous surveys of candidates and voters as well as quantitative analysis of campaign materials indicate that candidates were less likely to make negative attacks on their opponents following the introduction of IRV. However, relying on survey information can be problematic. For example, Palfrey & Poole (1987) are able to compare survey results to actual voting behavior and find that approximately 40% of non-voters in their sample inaccurately reported that they had voted. This paper is the first to use modern, natural language processing techniques to analyses the civility of debates and is also the first to make use of the large amount of transcribed debates that are now available from data sources like YouTube. The use of natural language processing techniques is a major contribution of this paper as it ensures impartiality and allows the analysis of civility to be done a scale not possible when using manual techniques.

The results of the analysis indicate that, in the Minneapolis-St. Paul Metro Area, the introduction of IRV caused a 9.6 percentage point increase in turnout for mayoral elections. The effect on turnout is larger for precincts that have higher poverty rates. This result is in line with the expectations of proponents of IRV, that it will increase turnout, but is somewhat counter to the bulk of the literature, which generally find no effect or that the introduction of IRV results in a reduction in turnout. Text based sentiment analysis of mayoral debates in a broader set of cities across the U.S. indicates that the introduction of IRV improved the civility of debates. The improvement in civility is due to candidates substituting negative or neutral words for more positive words throughout the debate. Again, this is in line with the expectations of proponents of IRV but also aligns with existing survey and hand-classification based research which tends to find that IRV improves civility.

This paper also makes a methodological contribution by calculating confidence intervals according to the approach of Conley & Taber (2011). Conley & Taber's approach allows for a small number of policy changers (treatment units) by using information from the larger sample of non-changing groups (control units). This is in contrast to regular inference in DID, which assumes that the number of treatment groups is large. This is an important contribution of this paper as previous research has used regular or clustered standard errors to conduct inference, likely overstating the statistical significance of the treatment effect due to the small number of areas that have used IRV in the U.S.

Section 3.1 gives a summary of approaches to aggregating preferences and the recently renewed interest in the adoption of IRV in the U.S. Section 3.2 provides a summary of the literature. The results of the literature review lead to the development of a research design and econometric specification in Section 3.3. The data sources are set out and summarized in Section 3.4. The main results of the analysis are presented in Section 3.5 with further robustness checks provided in Section 3.6. Section 3.7 concludes.

3.1 Background

This section first provides some general background on FPTP and IRV and then presents some recent background on the transition towards IRV in the Minneapolis-St. Paul Metro Area in particular.

3.1.1 Background on IRV

The main two approaches for aggregating preferences in the U.S. and of relevance to this paper are FPTP and IRV. IRV is known by many different names but, for consistency, IRV is used throughout this paper to avoid any potential confusion with other voting systems.[5]

[5] IRV is also known as Alternative Voting, Ranked Choice Voting and Preferential Voting and is occasionally misnamed Single Transferrable Vote (STV)

Generally speaking, FPTP awards the election to whichever candidate receives the most votes whereas IRV iteratively removes the candidate with the least number of votes until one candidate has a majority of votes. An important difference between the two systems is that FPTP only requires one candidate to be identified on the ballot as the most preferred whereas IRV requires either a partial or full ranking of all candidates on the ballot.

IRV and FPTP are two of a large range of voting rules that have been proposed and used in elections. Common electoral systems in use around the world today for single member constituencies include FPTP, Two-Round Systems (TRS), and IRV. Other systems that have been proposed and studied theoretically but are rarely used in practice include Borda Count (Black, 1976), Kemeny-Young (Kemeny, 1959) and Majority Judgement (Balinski & Laraki, 2011).

The existence of many different electoral systems may be related to theoretical results from Arrow (1950) who shows that no election system can satisfy a small and reasonable set of desirable criteria at the same time[6], and Gibbard (1973) and Satterthwaite (1975) who show that all voting systems are open to manipulation through tactical voting.[7] That is, all voting systems have flaws.

FPTP is used in over 40 countries, including major democracies such as the U.S., Canada, UK and India. Historically, IRV is far less common and is used in state and federal elections in Australia; in presidential elections in Ireland; and by some jurisdictions in the U.S., United Kingdom, and New Zealand. A similar method to IRV that is used for multi-member constituencies, Single Transferrable Vote (STV), is also used in national elections in the Republic of Ireland and Malta; it is also used in some elections in Australia, Northern Ireland, Scotland, New Zealand and the United States.

IRV was invented by a U.S. professor, W.R. Ware, in 1871 as a modification to Thomas Hare's

[6] Specifically, in elections involving three or more options, no ranked choice electoral system can aggregate preferences in a way that is complete and transitive while maintaining the properties of unrestricted domain, non-dictatorship, Pareto efficiency, and independence of irrelevant alternatives.

[7] Specifically, for any deterministic ordinal electoral system that chooses a single winner, one of three situations must hold: the rule is dictatorial; the rule limits the possible outcomes to two alternatives only; or the rule is susceptible to tactical voting

earlier proposals (Reilly, 2004). In the U.S., IRV was popular in the first half of the 20^{th} Century. Various preferential voting systems were used for local elections in around two dozen cities over the course of the early 20^{th} Century (Reilly, 2004). But reform movements, often sponsored by party machines, led to their replacement, in virtually all cases, by plurality systems (Reilly, 2004). IRV, in particular, was repealed shortly after being passed in cities and states in nearly two-thirds of the jurisdictions in which it originally passed; including Boulder, CO; Cincinnati, OH; and Ann Arbor, MI (Rhode, 2018). By 1962, only Cambridge, MA retained the system (Amy, 1996). Consequently, since the mid-20th Century, American elections have almost universally used a FPTP system for electing candidates (Amy, 1996).

There is no consensus on whether IRV or FPTP is preferable. For example, the IGM Economic Experts Panel economists remain mixed in their view of whether IRV is superior to other voting methods (IGM Forum, 2018). A range of authors including Kimball & Anthony (2016), Rhode (2018), Reilly (1997), Sutherland (2016) and Fraenkel & Grofman (2004) do identify a core set of expected benefits of IRV, which can be summarized as:

- Ensuring majority support for winners: with reference to Definition **??**, it's clear that, in theory, the winner should have majority support.

- Reducing costs of run-off elections: with reference to Definition **??**, by moving progressively through preferences stated by voters, IRV removes the need for multiple rounds of elections and should conceptually reduce costs.

- Encouraging collaboration and civility among competing candidates: in some cases, negative campaigning could turn voters away from placing a candidate second or third in their ranking and so candidates may potentially use more positive communication styles.

- Reducing conflict and tension between ethnic groups: voters from minority ethnic groups can vote for their preferred candidate first, who may have little chance of reaching majority support, while still expressing preferences over other candidates and influencing the final result.

- Allowing voters to provide a more complete and non-strategic report of their preferences: Bartholdi & Orlin (1991) show that under STV, which is essentially identical to IRV from a strategic point of view, strategic manipulation of a vote is an NP complete problem even in an election for a single seat.

- Providing incentives for more and more diverse candidates to run for office: candidates who have a low chance of being elected can choose to run without fear that they will 'split the vote' of other similar candidates and cause an opponent to be elected. It's worth noting that having more and more diverse candidates may lead to changes in other outcomes such as civility and conflict.

On the basis of the perceived benefits, proponents of IRV often argue that it will increase voter participation and engagement (McDaniel, 2019). Richie et al. (2000) state that "the combination of better choices, less money in politics, clearer mandates and less negative campaigning could lead to higher voter turnout and increased overall participation in politics."

Interestingly, based on a phone survey of voter preferences, application of IRV to the national presidential election for 2016 indicates that Hilary Clinton would likely have won the presidency with 54% of the final round vote (Trump receiving 46% of the final round vote). This result is closer to the national popular vote where Clinton received 48.2% and Trump 46.1% (Igersheim et al., 2018) than that delivered by the Electoral College.

Recently, concerns have been raised that FPTP elections may adversely affect political equality and fair representation (FairVote, 2019). Since 2000, likely spurred on by the highly contested Presidential election, there has been renewed interest in implementing IRV in the U.S. (Reilly, 2004). In the early 2000s, newspaper endorsements for using IRV came from USA Today; major articles and commentary about IRV appeared in publications, such as the New York Times, the Wall Street Journal, and the Washington Post. Support for IRV was also given by groups, such as the League of Women Voters (Richie & Hill, 2001). A major impediment to implementation of IRV in the early 2000s was that the voting machines used in most U.S. jurisdictions were not equipped to handle ranked ballots (Reilly, 2004).

Following two decades of increasing momentum and improving voting machine technology, as of early 2018, around a dozen different municipalities are actively utilizing some form of IRV to elect officials. The majority of these cities first implemented IRV in the years since 2010 (Rhode, 2018). This includes in state and congressional elections in Maine (since 2018) and in local elections in 11 cities, including San Francisco (since 2004), Oakland (since 2010), Berkeley (since 2010) and Santa Fe (since 2010). Recently, using IRV for elections in the U.S. Congress has been endorsed by The New York Times (2018) and has recently been adopted in New York City for specific elections.

3.1.2 Implementation of IRV in Minnesota

Within Minnesota, IRV has been adopted by the two municipalities that make up the core of the Minneapolis-St. Paul Metro Area[8]. Minneapolis-St. Paul, often referred to as the Twin Cities, is a large metropolitan area of around 4 million people. The core of the Metro Area is based on the municipalities of Minneapolis, the most populous city in Minnesota and seat of Hennepin County; and St. Paul, the state capital of Minnesota and seat of Ramsey County. Minneapolis has a population of around 422,000 whereas St. Paul has a population of around 310,000. Both Minneapolis and St. Paul are independent municipalities with defined borders, electing separate councils and mayors. Municipal elections are, however, coordinated across Minnesota, meaning that municipal elections occur at the same time in both Minneapolis and St. Paul.

In this paper, the Minneapolis-St. Paul Metro Area (also referred to as the Twin Cities area) is defined as the seven counties that make up the Metropolitan Council[9]. In the data used in this paper, these seven counties contain 152 municipalities.

On November 7, 2006, voters in the Minneapolis municipality (the most populous municipality in the Minneapolis-St. Paul Metro Area) approved the use of IRV to elect the city

[8] The potential for using IRV is also under consideration in Rochester, MN and is expected to be implemented in St Louis Park, MN in 2019.

[9] The seven counties in the Metropolitan Council's Twin Cities Metropolitan Area are: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties.

Table 3.1: Twin Cities' Mayoral Elections

	Minneapolis	St. Paul
2001	FPTP	FPTP
2005	FPTP	FPTP
2009	IRV	FPTP
2013	IRV	IRV
2017	IRV	IRV

Notes: Mayoral Only

Source: Author's calculations

council and mayor by a 65% majority[10]. This was the third effort at a charter amendment after failed attempts in 1999 and 2001 (Schultz & Rendahl, 2010). On November 3, 2009, IRV was implemented for the first time as a voting mechanism in Minneapolis (Schultz & Rendahl, 2010). In its first implementation in Minneapolis, the election involved a popular incumbent, Mayor R. T. Rybak, who received 74% of the first preference vote.

In general, Minneapolis aimed to be the "Gold Standard" (Chadha, 2019) of IRV implementation and sought to achieve cost reductions and increased turnout, ensuring that elected candidates receive a majority of votes and encouraging support for third parties (Schultz & Rendahl, 2010).

Similarly, in 2009, voters in the Saint Paul municipality (the second most populous in the Minneapolis-St. Paul Metro Area) approved the use of IRV in elections for city council and mayor. The first mayoral election using IRV was held in 2013 and, as with Minneapolis, the first outing involved an incumbent mayor, Chris Coleman, who received 78% of the first preference vote.

This means that the voting systems shown in Table 3.1 have been used in the Twin Cities for recent elections.

From an administrative point of view, the initial implementation in Minneapolis was largely seen as a success with the major issue being that hand-counting and verification in Minneapo-

[10]Note that IRV is not used for elections for the Minneapolis School Board, or the county, state or federal offices.

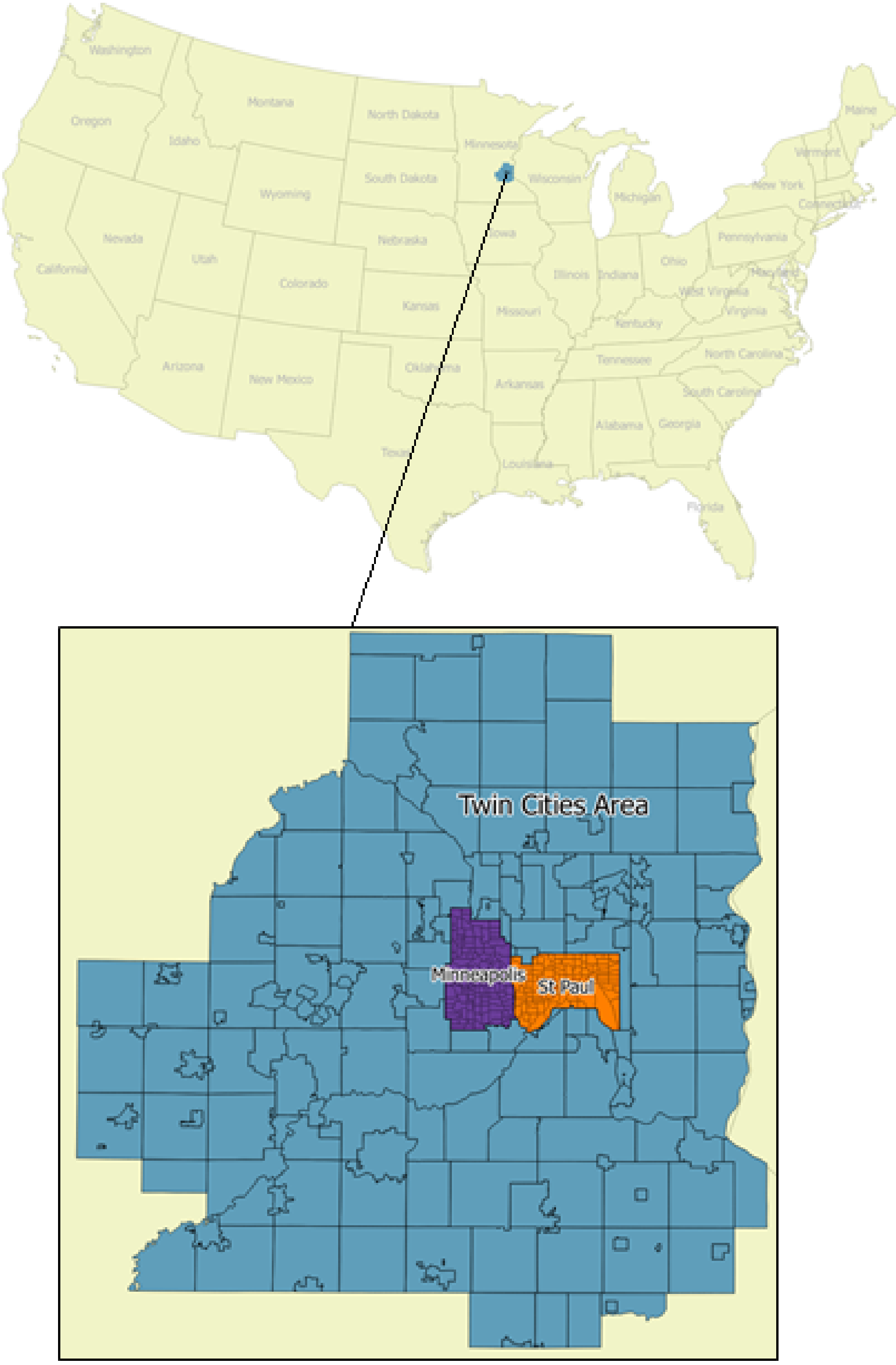


Figure 3.1: Minneapolis-St. Paul Metro Area Municipalities Showing Minneapolis and St. Paul's Voting Precincts

Note: The Minneapolis municipality is shown in purple and the St. Paul municipality is shown in orange. Heavy lines within the Metro Area show municipalities while lighter lines within Minneapolis and St. Paul show voting precincts
Source: Based on data from Minnesota Legislature (n.d.)

lis took a long time (Aiba et al., 2012).

The 2013 Minneapolis election was also seen as a success, with turnout over 80,000, the highest for a municipal election in 12 years. In the city's most ethnically diverse ward, voters understood and appreciated IRV. Moreover, 75% of voters ranked two choices, and 63% ranked all three available choices in the council race (Chadha, 2019).

In the 2013 Minneapolis election, there was no incumbent candidate and 35 candidates ran for election. Because voters were able to rank up to three candidates on their ballot, voting went to the 33rd round and took two days of tabulation to find the winner. Competition and debate in the 2013 Minneapolis election was noted as being particularly civil. In 2018, the Minneapolis city clerk noted that "the tone and rhetoric of the [2013] campaign was much more focused on policy and issues and priorities, what you would do as mayor, and less about the traditional attack ads against their opponents... at one point in the 2013 mayoral debate, the candidates linked arms and literally sang 'Kumbaya', refusing to insult one another out of fear of losing voters" (News Centre Maine, 2018). Commentators generally considered that this civility could be attributed to candidates not wanting to alienate voters who may rank them second or third on the ballot. The 2013 mayoral campaign was also seen as enabling more politically diverse candidates to run in the election. An example is the candidacy of Cam Winton who ran as an independent on a moderate-conservative platform –- which isn't common in Minneapolis mayoral elections.

St. Paul had a similar experience to Minneapolis on its second outing with IRV: the incumbent mayor decided not to run, resulting in a contest between six candidates. The successful candidate, Melvin Carter, is the first African American mayor of the city.

3.2 Evidence in the empirical literature

This section provides a detailed review of previous analyses of the performance of IRV, first covering general findings then considering turnout and civility in more detail.

3.2.1 General Findings

In terms of a basic understanding of IRV, Neely et al. (2005) conduct a survey of voters in San Francisco in 2014 and find high levels of understanding of IRV with a majority (61%) preferring IRV over the runoff system that was previously used in San Francisco. Based on a phone survey of voters in a number of locations, Douglas (2014) reports that over 90% of those surveyed considered the instructions on how to complete their IRV ballot were either somewhat or very easy to understand. Donovan et al. (2019) find that voters in IRV cities are more likely to report that understanding voting instructions was "very or somewhat difficult" compared to voters in plurality voting systems. Neely & Cook (2008) show evidence that minority groups, such as Latinos and the elderly, may find it particularly challenging to make use of IRV ballots. These results are supported in follow up research by Neely & McDaniel (2015) who identify that, under IRV in San Francisco, voided ballots are consistently more common in precincts where more African-American citizens reside, and are often observed at higher rates in precincts that contain more Latino, elderly, foreign-born, and less wealthy residents. It is worth noting that very similar results are also found by Sinclair & Alvarez (2004) when looking at voting via punch cards in Los Angeles, which may indicate that previous findings are not solely related to the presence of IRV but may be a general feature of 'complicated' voting procedures.

Adequate understanding of IRV may, however, not be sufficient to achieve support for its use. Using an experimental survey, Nielson (2017) found that, while participants were largely able to understand the rules of IRV, voting in an IRV election did not have any measurable impact on attitudes toward elections, nor did participation in an IRV election lead to an increase in preference for IRV elections. However, in Minneapolis Chadha (2019) reports that a plurality of voters (41%) preferred IRV with older, more educated, wealthier and white voters preferring IRV more strongly.

Further, due to exhausted ballots (where the candidates who a voter ranks are not elected), when examining results from four IRV elections Burnett & Kogan (2015) calculate that the winner never receives a majority of the total votes cast. A similar finding is made by Endersby & Towle (2014). One contributor to the prevalence of exhausted ballots is an apparent preference among many voters for only ranking a small number of candidates. Undertaking a review of ballots from Ireland, Laver (2004) finds that the modal number of preferences recorded was three while the median was four (in elections with between 9 and 14 candidates).

With respect to cost reduction, Rhode (2018) uses a matched DID approach to compare expenditure between IRV and FPTP cities and finds no statistically significant change in expenditure. In fact, Rhode (2018) finds that in the years before IRV was implemented, the cities that would implement it spent more per election cycle than control cities, $3.39 compared to $1.24. Anthony et al. (2019) conduct a survey of election administrators in Maine and conclude that "most municipal clerks in our sample are not enthusiastic about implementing ranked choice voting and do not want to continue its use in Maine."

Considering the diversity of candidates, John et al. (2018) use a DID strategy to analyse how the representation of women and minorities changed in San Francisco following the introduction of IRV. They find that IRV resulted in an increase in the share of minority candidates and an increase in the share of female victors. However, there was no statistically significant effect on minority victors or female candidature. These results broadly align with earlier cross sectional analysis of across the U.S. by Trebbi et al. (2008), finding that the electoral rule adopted by a city is associated with the representational ratio of minorities.

Despite an apparent increase in candidate diversity, McDaniel (2018) uses ecological inference and DID on data from Oakland and San Francisco to show that the introduction of IRV has very little, if any, effect on racially polarized voting and does not contribute to any moderation of racial conflict or competition. There is even some evidence to show that it may contribute to higher levels of racial polarization.

Felsenthal et al. (1993) who, by recalculating the results of elections under different voting rules, find that there is no significant difference among a number of voting procedures (including IRV) in terms of preserving the social preference ordering nor of electing the candidates who ought to be elected.

3.2.2 Participation

A number of papers estimate that the introduction of IRV results in a reduction in turnout. Cook & Latterman (2011) note that turnout in San Francisco's 2011 Municipal election (which used IRV) was considerably lower than in either the midterm election of 2010 or the 2008 presidential election. Looking at voting in Oakland, CA, Holtzman & Nall (2012) find that IRV had a negative effect on turnout in 2010 relative to 2006. Using ecological inference and controlling for relevant socioeconomic covariates McDaniel (2016) finds that use of IRV in San Francisco decreased turnout for black (18 percentage points) and white voters (16 percentage points). In a recent working paper, McDaniel (2019) uses a DID of matched cities throughout the U.S. and finds a significant decrease in voter turnout of approximately 3–5 percentage points in IRV cities after the implementation of IRV. Despite using national data, this result may reflect the fact that much of McDaniel's treatment and control group is drawn from California, making it similar to previous analyses.

Analysis of implementation of IRV in the U.S. in the early 20^{th} century generally concludes that there was no meaningful effect on voter turnout Amy (1996). Similar findings have been made for Canada in the same time period (Jansen, 2004). Using more up to date data and approaches (a DID of matched cities throughout the U.S.), Kimball & Anthony (2016) come to a similar conclusion: IRV does not appear to have a strong impact on voter turnout in municipal elections. Kimball & Anthony (2016) do observe higher rates of spoiled ballots in the IRV elections than in the plurality election.

There are a small number of papers that find an increase in turnout. Looking at a particular race, the Assessor Recorder race in San Francisco in 2005, Jerdonek (2006) estimates that turnout increased by an average of 2.7 times following the introduction of IRV. Robb (2011) finds a positive correlation between the use of IRV and higher turnout rates in San Francisco with turnout being significantly higher after the 2004 implementation of IRV than it was before. Although unable to make inferences about IRV, Sutherland (2016) does note that cities that adopt 'nonpartisan alternative variable' voting approaches (which includes IRV) had the highest level of turnout.

There has been a range of findings on turnout as seen in Minneapolis. Schultz & Rendahl (2010), looking at trends over time, find that IRV did not increase voter participation compared to participation in previous municipal elections, though it did not appear to be a cause of non-voting. Further, McDaniel (2019) finds no statistically significant effect for turnout in Minneapolis following the introduction of IRV.

Many studies also consider the effect that IRV has on specific groups within the community. The majority of studies find that IRV has disproportionate effects on certain groups, particularly minorities or at-risk groups. Cook & Latterman (2011) find that precincts with higher proportions of Asian and Pacific Islander, Latino, and older voters were disproportionately likely to make mistakes on ballots in San Francisco. Similarly, in Oakland, CA, Holtzman & Nall (2012) find that Asian and Latino turnout declined during the transition to IRV.

In contrast, using a more sophisticated matched DID approach, Kimball & Anthony (2016) find similar levels of socioeconomic and racial disparities in voter participation in FPTP and IRV elections. Similarly, McDaniel (2016) found no statistically significant difference in Asian or Latino turnout associated with IRV in San Francisco. More complicated is Donovan et al. (2016) who find that older voters are significantly less likely to report understanding IRV systems but find no racial disparities.

Considering Minneapolis in particular, for the 2013 election (which used IRV), Kimball & Anthony (2016) do find that voter participation in the mayoral contest was higher in the wards with the highest share of white voters. This finding aligned with earlier, more simple analysis from Jacobs & Miller (2014) who found that, in the 2013 elections, voters who were more affluent and white turned out at a higher rate, completed their ballots more accurately, and were more likely to use all three opportunities to rank their most preferred candidates compared to voters living in low-income neighborhoods and in communities of color. These two findings are in contrast to FairVote Minnesota's determination that there were no significant discrepancies across demographic groups in understanding and casting of ranked choice ballots in Minneapolis in 2013 (Mauter, 2014).

Much of the available research to date is based on surveys and analysis of trends over time. Relying on survey information can be problematic. For example, Palfrey & Poole (1987) are able to compare survey results to actual voting behavior and find that approximately 40% of non-voters in their sample inaccurately reported that they had voted when, in fact, they did not vote.

The most sophisticated analyses in this area, many of which are working papers, tend to use data for many cities and use a matched DID approach.[11] This approach is problematic as the common trends assumption is unlikely to hold across the range of cities in the analyses. For example, McDaniel (2019), which is the most recent and thorough of these papers, notes that "visual inspection of the data does suggest that the comparison group election data may present a violation of the parallel trends assumption." Given the likely violation of the common trend assumption, the conclusions from these previous papers may not be reliable. This paper contributes to the literature by focusing on an in-depth analysis of a single metro area where the common trends assumption does hold and can be more carefully analyzed.

3.2.3 Civility

The decision to go negative in a campaign has been studied both theoretically and in practice. Theoretically, Skaperdas & Grofman (1995) construct a model of negative campaigning with the main conclusions being that the front runner is less likely to go negative, 3rd party spoiler candidates are likely to go positive, and stronger candidates are unlikely to go negative against weaker candidates. In practice, Damore (2002) analyses information from media campaigns and finds that candidates who are trailing in pre-campaign polls are more likely to attack, attacks are more likely to occur as election-day approaches, and that candidates respond to attacks by their opponents with attacks of their own. Peterson & Djupe (2005) undertake a text analysis of all Senate primaries in 1998 and identify that negativity is a function of the timing

[11] In this approach the reference group is made of cities that continue to use FPTP voting.

of the race, the status of the Senate seat, and the number and quality of the challengers.

The relationship between civility and turnout is unclear. For example, Djupe & Peterson (2002) present evidence based on analysis of newspaper articles that shows that campaign negativity boosts turnout in primary elections for Senate candidates with negative campaigns receiving more media coverage. This is different from earlier work from Ansolabehere et al. (1994) who find that the exposure to negative advertisements lowered intentions to vote by 5%, consistent across election data and experiments.

Considering how negativity is related to IRV, there have been a number of surveys of both candidates and voters. FairVote (2014) conducted a phone survey across IRV and FPTP locations and found that both voters and candidates reported less negativity in IRV locations than FPTP locations. Donovan et al. (2016) also use a survey across both IRV and FPTP locations to analyse perceptions of civility and find that both voters and candidates are likely to view campaigns as less negative when conducted under IRV. Similar results are also reported in Douglas (2014). From the same survey data, Tolbert (2014) identified that IRV elections increase: 1) perceptions of the fairness of the election; 2) the frequency of candidates praising or cooperating with their opponents; 3) general interest in the election; 4) usefulness of campaign information; and 5) satisfaction with the choice of candidates. In a phone survey focused on California, John (2015) finds that candidates spent less time criticizing opponents in IRV cities than in cities that did not use IRV and that respondents reported less negative campaigns in IRV cities. These findings are essentially repeated in John & Douglas (2017).

Looking only at candidates' perceptions of civility across a range of IRV and FPTP cities, Donovan (2014) notes that IRV candidates were more likely to hire staff, more likely to spend money on internet ads, less likely to report spending funds on radio and TV ads, spend less time on the phone and less time meeting with staff, spend more time knocking on doors, and were less likely to report that their rivals described them in negative terms.

In contrast, Neely et al. (2005) use a survey of voters in San Francisco in 2004 and find that they were split on whether the campaigns were more or less negative compared to past elections (14% said more negative, 15% said less negative). These perceptions are, however, at odds with surveys of candidates and quantitative analysis of campaign mailers from San Francisco. Robb (2011) shows that there was a considerable increase in activity of cooperative campaigning in the first year of IRV and a decrease in negative campaigning.

Focusing on Minneapolis itself, analysis of civility has been more difficult to conduct. For example, Schultz & Rendahl (2010) find that, in the 2009 Minneapolis election, campaigns focused heavily on voting method and less on the issues, making inferences about civility challenging. Relying on interviews with candidates, Mauter (2014) generally found that the introduction of IRV helped to create a more inclusive election in 2013 in Minneapolis and that campaigns mostly did not use negative campaigning. Quoting an interview with candidate Shultz shows some of the logic behind this finding:

> "For instance where Mark Andrew said about Betsy Hodges, she has the disease of a small vision. I mean that was a big deal. In any other political context, it would have been nothing, but the fact that it was so jarring because it was really one of the only instances we had in the campaign we could point to of actual negativity happening...(Mauter, 2014)."

The extant analyses of civility in IRV elections use either opinion polls or subjective personal identification of tone, rather than objective measures. This paper contributes by using a modern, natural language processing approach that impartially analyses the civility of debates. This is an important improvement in ensuring the veracity of the conclusions on civility.

3.3 Research design and econometric specification

The section sets out the different approaches used to address how IRV has affected voter participation and candidate civility.

3.3.1 Participation

Participation focuses on voter turnout, which is the percentage of eligible voters who actually cast a vote. Turnout is an important measure of the performance of a democratic election as higher levels of turnout can potentially indicate an election that is more closely followed by the electorate, more important for the electorate and ultimately may result in representatives who have greater support among the electorate.

Turnout is seen as an outcome that could be improved by IRV as, in FPTP voting, if a voter believes that their preferred candidate does not have a plurality then there may be little incentive to cast a 'wasted' vote for a losing candidate. In contrast, in an IRV system, this voter can cast their first preference for their most preferred candidate without the concern that their vote will be 'wasted'.

Elements of how IRV was introduced in the Minneapolis-St. Paul Metro Area allow for identification of the effect of introducing IRV on voter turnout. In particular, there was a staggered introduction of IRV between Minneapolis and St. Paul while the rest of the Metro Area retained the existing FPTP approach to elections over the same period. Further, IRV was only introduced for metropolitan level elections. In other elections (such as state and federal), the existing FPTP system was retained. These circumstances create a strong case for a natural experiment in the introduction of IRV in Minneapolis and St. Paul.

Analyzing the impact of the introduction of IRV on turnout is possible using a staggered DID approach of the form shown below. Using a staggered DID makes use of both the difference in timing of the introduction of IRV between Minneapolis and St. Paul as well as the fact that nearby municipalities did not change at all:

$$Turnout_{it} = \beta_0 + \beta_1 IRV_{it} + \gamma_t + \delta_i + \beta_2 NME_{it} + \beta_3 X_{it} + \varepsilon_{it}, \tag{3.1}$$

where i indexes municipalities (such as Minneapolis, St. Paul, St. Louis Park, etc. that are in the Minneapolis-St. Paul Metro Area during the transition period from FPTP into IRV) and t indexes the election period.

In this specification, turnout is measured as the share of registered voters who vote (normally referred to as Registered Voter turnout). This is in line with common approaches from the literature. In a meta-analysis of work on voter turnout, Stockemer (2017) finds that about two-thirds of existing studies use Registered Voter turnout[12].

For fixed effects, γ_t is a time fixed effect while δ_i is a municipality fixed effect. *NME* is an indicator variable for non-mayoral municipal elections. This variable accounts for cases where a municipal election is held for lower level offices – for example, St. Paul's 2015 election was just for City Council positions, not for mayor.The variable is included as the turnout for non-mayoral municipal elections is likely to be lower than for mayoral municipal elections and, due to differences in timing between different municipalities, this would not be captured in year fixed effects. X is a vector of covariates, such as demographic characteristics, if available. The possibility that the error term is correlated within a metropolitan area is accounted for through the use of clustered standard errors (Bertrand et al., 2004). In this specification β_1 will indicate whether the use of IRV resulted in an increase in voter turnout.

Due to the small number of treated units, confidence intervals computed using the approaches described by Conley & Taber (2011) are also be reported. Conley & Taber's approach allows for a small number of policy changers (treatment units) by using information from the larger sample of non-changing groups (control units). This is in contrast to regular inference in DID, which assumes that the number of treatment groups is large[13]. This is an important contribution of this paper as previous research has used regular or clustered standard errors to conduct inference, likely overstating the statistical significance of the treatment effect due to the small number of areas that have used IRV in the U.S.

[12] One-third of the studies use Voting Age Population turnout.

[13] As there are only two treated units, the confidence intervals reported are generally estimated using the approach described under Proposition 1 in Conley & Taber (2011), which uses a direct calculation. Where this is not the case it is explicitly noted in the table notes. The approach to calculating the Conley & Taber confidence intervals used in this paper differs slightly from Conley & Taber's approach and code. In this approach, the set of control observations in the data is limited to those that have observations available for the years where the treated units receive treatment. This alteration from Conley & Taber's approach is required to account for the fact that each municipality only has one observation per year and the panel is not balanced. Conley & Taber's approach requires either a balanced panel or multiple observations per time period to allow re-weighting of control observations to match treated observations.

The algorithm developed also allows for corrections due to the presence of heteroskedasticity in the data. A detailed review of the data indicated that heteroskedasticity based on municipality population is not present and that attempting to correct for the presence of such potential heteroskedasticity does not affect the overall results of the Conley & Taber confidence intervals.

A key assumption here is that Minneapolis and St. Paul follow the common trends assumption. This assumption requires that the trend that control units show over time would have applied to the treated units if they had not been treated. The assumption is critical as ensures that control units provide an appropriate counterfactual for the treated units. The fact that the two areas are part of a single conurbation involving municipalities that were not treated is likely to support a common trends assumption, but this will be covered in more detail in the following data section.

3.3.2 Civility

Civility focuses on the messages and communication style of candidates during the campaign. In particular, based on the literature review, the expectation is that the candidates should use more positive communication styles under IRV. Civility is important as previous literature has found that it can have a meaningful impact on participation of voters during elections (see Ansolabehere et al. (1994) for example).

This analysis focuses on communication during mayoral debates, which is anticipated to improve after the introduction of IRV. The mechanism is that, under IRV, a candidate can still benefit from being a voter's second or third choice. A candidate may consider that negative campaigning will turn voters away from placing them second or third, potentially leading the candidate to make fewer or less negative statements throughout the debate.

Analysis of the change in civility is based on a text-as-data approach (Gentzkow et al., 2019a). Sentiment analysis of debate transcripts using standard lexicons is able to provide a quantitative measure of the tone of language used in a debate that is summarized in a single numerical score for each debate. The resulting score can then be used as the dependent variable in further regressions. The sentiment analysis process is described further in Section 3.4.2.

Similarly to the analysis of participation, this structure allows for the use of a staggered DID approach of the form shown below:

$$Sentiment_{it} = \beta_0 + \beta_1 IRV_{it} + \gamma_t + \delta_i + \beta_2 X_{it} + \varepsilon_{it}, \tag{3.2}$$

where i indexes municipalities (such as Minneapolis, St. Paul, San Francisco, Oakland, etc. across the entire U.S.) and t indexes the election period.

The dependent variable for sentiment will be measured in a number of different ways, explained in more detail in 3.4.2. Regardless of the approach to measurement, a higher value will indicate higher levels of civility.

For fixed effects, γ_t is a time fixed effect while δ_i is a municipality fixed effect. X is a vector of covariates, such as demographic characteristics, if available. It is assumed that the error term $\varepsilon_{i,t}\ N(0, \sigma_i^2)$ and that errors can be correlated within a metropolitan area through the use of clustered standard errors (*Bertrandet al.*, 2004). Due to the small number of treated units, confidence intervals computed using the approaches described by Conley & Taber (2011) will also be reported. In this specification, β_1 will indicate whether the use of IRV resulted in an improvement in debate civility.

As with participation, the key assumption here is that treated municipalities follow a common trend in sentiment with areas that were untreated.[14] The relevant scarcity of debate recordings means that, unlike participation, the data for analysis of civility is based on a group of cities from across the U.S. As a result, the common trends assumption may be weaker than in the analysis of participation. This will be covered in more detail in the following section.

[14]As stated previously: this assumption requires that the trend that control units show over time would have applied to the treated units if they had not been treated. The assumption is critical as ensures that control units provide an appropriate counterfactual for the treated units.

3.4 Data

3.4.1 Participation

The main piece of data required to analyze participation is voter turnout for each election in the Minneapolis-St. Paul Metro Area at the municipality level. For the analysis of participation, the treated units are the Minneapolis and St. Paul municipalities while the control units are all the other municipalities in the Minneapolis-St. Paul Metro Area. Due to the staggered timing of implementation, St. Paul enters treatment later than Minneapolis.

Data on voting is available from the Minnesota Secretary of State (n.d.) for every metropolitan area in the state of Minnesota and is available in detailed machine readable formats for elections going back to 1992. The lowest level of data available is at the precinct level[15] and, although data varies from year to year, there is generally data available for each precinct in each election on the number of registered voters as well as the number of ballots received. The aforementioned two pieces of data allow for turnout to be calculated.

Reporting complete data to the Secretary of State is not compulsory and so, to ensure complete data coverage for treated locations, voting data for Minneapolis and St. Paul was sourced from their respective electoral agencies, the City of Minneapolis (n.d.) and Ramsey County (n.d.).

Voting data from the year 2000 onwards was compiled and resulted in around 47,000 precinct level observations. Removing data for school board districts, which are not of interest in this paper, results in around 44,000 remaining observations spread across 2,600 metropolitan areas from across the entire state of Minnesota. A density plot of the turnout rate is shown in the figure below.

This main data source was merged with other supporting information. First, data on the type

[15] Precincts roll up into wards and then into Municipal areas. Municipal areas themselves roll up into counties which then roll up into state level data. The Minneapolis-St. Paul Metro Area is used throughout the analysis and is defined as the seven counties that form the Metropolitan Council's Area: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties. The Minneapolis-St. Paul Metro Area does not elect representatives as a single geography to any level of representation. The Minneapolis-St. Paul Metro Area also does not map neatly to any Federal level election area as it includes parts of five different congressional districts.

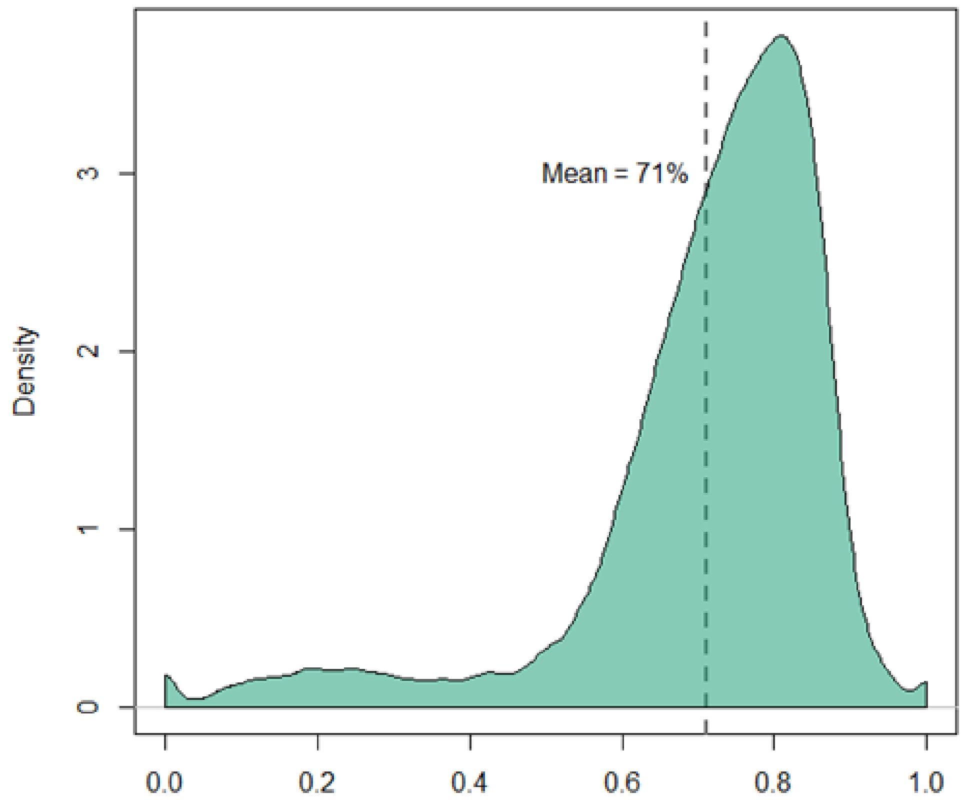


Figure 3.2: Kernel Density Plot of Voter Turnout at Precinct Level

Note: Bandwidth = 0.0125

Source: Author's calculations based on data from Minnesota Secretary of State (n.d.)

of each election was included (including date, whether it was a Presidential election, a mid-term election, a state election, a municipal election and/or a mayoral election). Next, data from the 2010 census sourced from the Minnesota Legislature (n.d.) was included. The census data is at the voting district level (which is a higher level of aggregation than the precinct level) and includes information such as population and race. After merging in census data, the number of observations reduced to around 39,000 as some precincts did not have identifying information in the census data. Finally, socioeconomic data at the County level sourced from the Minnesota Department of Health (n.d.) was included. This data covers the number of households, the percentage of elderly and young, unemployment, the number of households on food stamps, average per capita incomes, poverty rates and the number of school students. This County level socioeconomic data only covers the years 2006-2016, resulting in a reduction in the number of observations down to around 23,000. In the results section, the sensitivity of the results to these data reductions is tested.

With this combined data set, the data was then aggregated up to the municipal level, as this is the level of treatment, reducing the observations to 220. The subset of municipal areas within the Twin Cities metropolitan area was identified. The Metropolitan Area was defined to include the seven counties of Hennepin, Anoka, Washington, Ramsey, Carver, Scott and Dakota that together form the Metropolitan Council. Attention was restricted to these locations as they are likely to present the best comparator group for Minneapolis and St. Paul. Again, in the results section, the sensitivity of the results to this data reduction is tested. This resulted in a final set of 168 observations for use in the regression analysis.

The following table provides a summary of the socioeconomic characteristics of the treated and control municipal areas within the Minneapolis-St. Paul Metro Area. In summary, municipal areas in the treatment group are located in counties that have slightly higher populations, higher rates of unemployment and poverty and lower household incomes.

Table 3.2: Summary of Socio-economic characteristics in Twin City Municipalities

	All Data		Municipal Elections		Other Elections		Treated		Control	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Votes	16, 240.49	33, 949.14	5, 748.95	12, 048.80	22, 710.28	40, 859.98	96, 637	62, 498.91	7, 511.73	9, 586.02
Turnout	0.52	0.28	0.20	0.10	0.72	0.11	0.50	0.24	0.52	0.28
Municipal Election	0.38	0.49	1	0	0	0	0.37	0.50	0.38	0.49
State General Election	0.62	0.49	0	0	1	0	0.63	0.50	0.62	0.49
Mid Term Election	0.31	0.46	0	0	0.50	0.50	0.32	0.48	0.31	0.46
Presidential Election	0.31	0.46	0	0	0.50	0.50	0.32	0.48	0.31	0.46
Mean Per Capita Income	51, 525.16	7, 554.29	51, 187.49	7, 115.37	51, 733.39	7, 834.67	51, 129.46	7, 373.11	51, 568.12	7, 593.16
Household Income	65, 259.98	11, 714.51	65, 666.24	11, 442.88	65, 009.45	11, 919.55	57, 394.38	5, 426.23	66, 113.96	11, 902.92
Unemployment (%)	4.97	1.49	5.37	1.71	4.72	1.28	5.12	1.50	4.95	1.49
Poverty (%)	11.08	4.20	11.06	4.43	11.10	4.06	13.92	2.36	10.77	4.24
Households on Food Stamps	32, 689.51	22, 867.06	32, 513.99	22, 992.72	32, 797.74	22, 885.15	40, 544.17	16, 993.94	31, 836.71	23, 295.01
Population	710, 598.90	426, 805.30	683, 677.20	428, 324.90	727, 200.60	426, 811.10	793, 793.20	335, 023.70	701, 566.30	435, 436.70
Households	291, 158.70	182, 394.20	279, 881.80	183, 541.00	298, 112.80	182, 104.20	326, 193.90	143, 085.80	287, 354.90	186, 101.50
School Students	92, 137.21	60, 339.76	99, 632.97	54, 946.58	87, 514.82	63, 217.19	104, 404.80	50, 996.68	90, 805.30	61, 247.07
Young (%)	29.89	3.19	29.88	3.35	29.90	3.10	28.53	1.15	30.04	3.30
Elderly (%)	16.72	2.83	16.55	2.89	16.83	2.81	18.18	1.46	16.57	2.90

Notes: Observation level is the municipality

Source: Author's calculations

To successfully apply the research design requires that the common trends assumption holds between the treatment group (made up of Minneapolis and St. Paul) and the control group (other municipal areas in the Minneapolis-St. Paul Metro Area). The likelihood of the common trends assumption holding can be tested by considering turnout in elections that should not be affected by the policy. The plots below show turnout levels over time for treated and control groups in mid-term and presidential elections respectively. Overall, it appears that both groups follow roughly the same time-trend and there appears to be little direct effect from the policy on turnout, particularly so for mid-term elections in Figure 3.3. This gives support to the common trends assumption being applicable for the case of municipal elections.

It's also possible to graphically see the likely treatment effect in the raw data. Looking at trends across time, as shown in the charts above, is challenging as year on year variation tends to dominate. However, simplifying into 'before' and 'after' groups clarifies the graphical analysis. Figure 3.5 shows turnout rates for municipal elections, while Figure 3.6 shows turnout rates for all other elections. Figure 3.5 indicates that the introduction of IRV may have led turnout to decrease more slowly than it otherwise would have, while Figure 3.6 – where there should be no treatment effect – indicates that some of this may have been due to an underlying increase in turnout in treated municipalities. Together this graphical analysis suggests that, in the raw data, the treatment effect of IRV is likely to be positive.

Figure 3.3: Turnout Rate in Unaffected Elections – Mid-Terms

Source: Author's calculations

Note: 'Control - All' refers to a control group made up of all municipalities in Minnesota while 'Control - Twin Cities' refers to municipalities within the Minneapolis-St. Paul Metro Area. For simplicity of presentation, the 'Treated' group contains both the Minneapolis and St. Paul municipalities in all time periods.

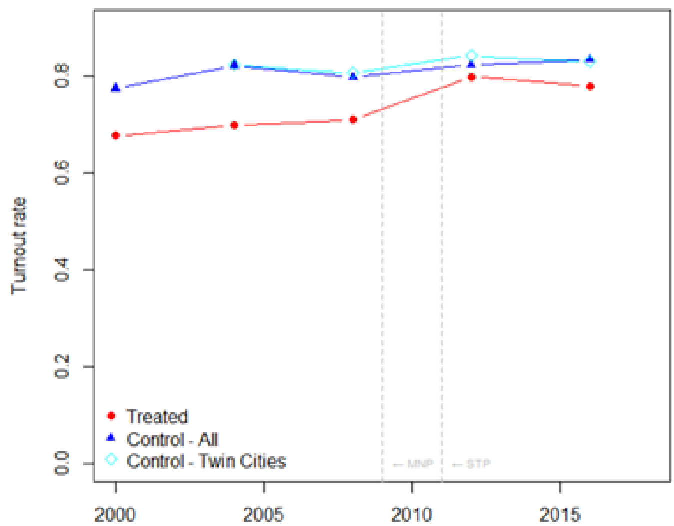


Figure 3.4: Turnout Rate in Unaffected Elections – Presidential

Source: Author's calculations

Note: 'Control - All' refers to a control group made up of all municipalities in Minnesota while 'Control - Twin Cities' refers to municipalities within the Minneapolis-St. Paul Metro Area. For simplicity of presentation, the 'Treated' group contains both the Minneapolis and St. Paul municipalities in all time periods.

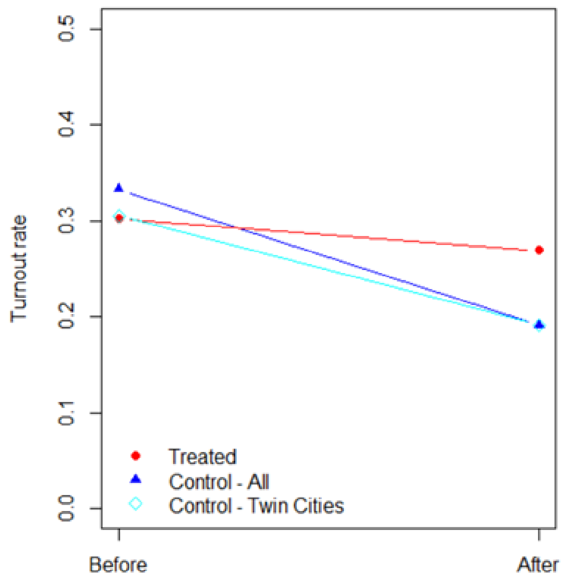


Figure 3.5: Turnout Rate in Municipal Elections

Source: Author's calculations

Note: 'Control - All' refers to a control group made up of all municipalities in Minnesota while 'Control - Twin Cities' refers to municipalities within the Minneapolis-St. Paul Metro Area. For simplicity of presentation, the 'Treated' group contains both the Minneapolis and St. Paul municipalities in all time periods.

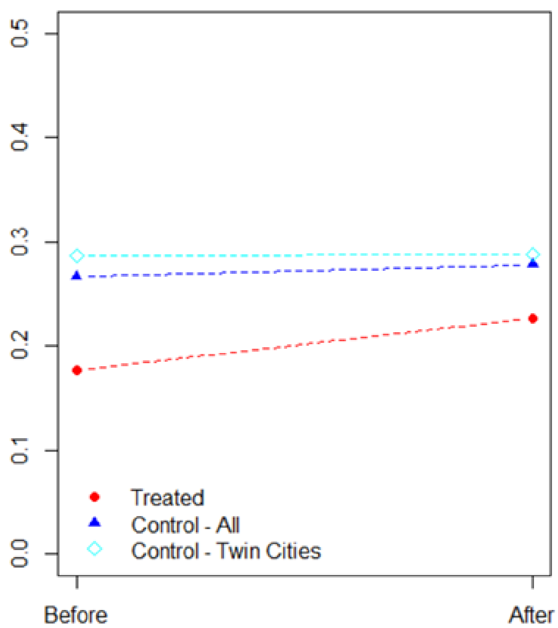


Figure 3.6: Turnout Rate in Non-mayoral, State and National Elections

Source: Author's calculations

Note: 'Control - All' refers to a control group made up of all municipalities in Minnesota while 'Control - Twin Cities' refers to municipalities within the Minneapolis-St. Paul Metro Area. For simplicity of presentation, the 'Treated' group contains both the Minneapolis and St. Paul municipalities in all time periods.

3.4.2 Civility

For Civility, the goal is to have a measure of civility in mayoral debates for a large range of cities across the U.S. For the analysis of civility, the treated units are large municipalities across the U.S. that have implemented IRV while the control units are large municipalities from across the U.S. that have not implemented IRV.

To do this, the main piece of data that is used are transcripts from mayoral debates. These transcripts were predominantly sourced from YouTube videos of mayoral debates. This paper is the first to use modern, natural language processing techniques to analyses the civility of debates and is also the first to make use of the large amount of transcribed debates that are now available from data sources like YouTube. The use of natural language processing techniques is a major contribution of this paper as it ensures impartiality and allows the analysis of civility to be done a scale not possible when using manual techniques.

A structured process was followed to identify and gather the transcripts. First, the largest 100 municipalities in the U.S., measured by population, were identified. These municipalities account for around 62 million people which is about 19% of the entire U.S. population. For each of these cities, a manual search on YouTube was undertaken to identify relevant videos. The search was based on the phrase "[City Name] Mayoral Debate", so that, for example, searching for New York City was done using the phrase "New York Mayoral Debate". Search filters were applied to return only videos longer than 20 minutes. This process identified a total of 459 relevant videos from 78 municipalities covering years from 1988 to upcoming elections in 2020. At this stage no account was made for whether the city used IRV or FPTP voting systems – all cities in the top 100 were treated the same.

A Python and R script was then used to check for the availability of subtitles for each video. Most of these subtitles are generated by Google's automatic speech recognition technology (Harrenstien, 2009)[16]. In total, 329 of the 459 videos had transcripts available, creating a total word count of around 3 million words. These videos covered 70 municipalities. At an average

[16] As at 2020, captions on YouTube's desktop site can be accessed by clicking the ellipses below a video and then clicking on the "Open Transcript" option.

speaking pace of 120 words per minute, this results in just over 400 hours of debate video for which transcripts are available.

This process did not identify any debate recordings for Minneapolis prior to the introduction of IRV. As a result, two additional recordings were sourced from PBS's video archive for the 2005 mayoral race (PBS, 2020). Additional research, including contacting previous candidates, organizations that hosted debates and Minneapolis Public Radio, did not identify further transcripts that could be added to the database.

As there is no thorough data available on the quality of Google's automated transcripts, the quality was verified by hand for all debates in Minneapolis in 2013. This hand verification indicated that the quality of the machine generated transcripts was good, with only minor corrections identified.

Some supporting socioeconomic data was sourced from the American Community Survey (ACS) (United States Census Bureau, 2019). Data was matched between the debate transcripts and the socioeconomic data using the main county in which the municipality is located. The ACS data was only available from 2010 to 2017 and, due to the presence of fixed effects, can only be used in regressions for cities that have debate transcripts available for multiple years. This restriction reduces the dataset to a final 227 debates from 37 cities. The remaining cities are reported in Appendix F.

The text from the transcripts was cleaned by converting it to lower case, removing excess spaces and whitespace, and removing punctuation and special characters. This created clean text data that could be used in the sentiment analysis.

The sentiment analysis was undertaken using both the AFINN and Bing lexicons. The AFINN lexicon assigns words with a score that runs between -5 and 5, with negative scores indicating negative sentiment and positive scores indicating positive sentiment (Nielsen, 2011). The AFINN lexicon contains around 2500 words. The Bing lexicon categorizes words into positive and negative categories, in this analysis these are coded as +1 and -1, respectively (Hu & Liu, 2004). The Bing lexicon contains around 7000 words. There are about 1300 words that appear in both the AFINN and Bing lexicons and only 17 where there is a disagreement between the two lexicons on whether the word is positive or negative in sentiment. To apply the lexicons, each word in each speech was checked against the lexicon and assigned its relevant score. There were only two words in the 2013 Minneapolis debates that were assigned a score of +5 using AFINN: these were 'outstanding' and 'superb'. Words with an AFINN of +4 in the 2013 Minneapolis debates include 'awesome', 'fabulous' and 'win'. On the negative side, there were no words used in the 2013 Minneapolis debates with an AFINN of -5 and the only word used with an AFINN of -4 was 'hell'.

The results of the sentiment analysis were summarized in a number of measures: the total number of words in the sentiment lexicon used during a debate; the average score of words in the lexicon used during a debate; and the average score of all words used in the debate. Table 3.3 provides a summary of the sentiment analysis for both the AFINN and Bing lexicons.

Table 3.3: Summary of Sentiment Analysis

	Min	Median	Mean	Max	SD
Word Count	286	9,689	9,503.7	24,326	4,438.3
AFINN Word Count	9	486	489.3	1,291	234.7
AFINN Total Score	-118	340	377.3	1,452	229.2
Average AFINN Score	-1.2	0.8	0.8	1.4	0.3
AFINN Per Word	-0.04	0.04	0.04	0.1	0.02
Bing Word Count	1	468	475.4	1,312	225.4
Bing Total Score	-13	174	187.8	620	107.7
Average Bing Score	-1	0.4	0.4	0.7	0.2
Bing Per Word	-0.003	0.02	0.02	0.04	0.01
Stop Word Count	2	5,857	5,694.0	14,538	2,672.9

Source: Author's calculations

In this table, Word Count is the total number of words spoken in a debate, AFINN/Bing Word Count is the number of words spoken that appear in the AFINN/Bing lexicon, AFINN/Bing Total Score is the sum of AFINN/Bing values for all words spoken in the debate, Average AFINN/Bing score is AFINN/Bing Total Score ÷ AFINN/Bing Word Count and AFINN/Bing Per Word is AFINN Total Score ÷ Word Count. In summary, an average debate has around 9,700 words (at around 120 words per minute, this is a speaking time of around 80 minutes).

Of these, around 490 words are in the AFINN lexicon and 470 in the Bing lexicon. The mean Bing Total Score of 188 indicates that, on average, there are more positive words said than negative words, but both the Average AFINN (mean 0.8) and Average Bing (0.4) indicate that the average word used, given that it is in the lexicon, is positive but not resoundingly so.

Stop Word Count records the frequency of use of common English language words. The list of words is based on a database compiled by Silge & Robinson (2016) but has been edited to remove words that appear in the AFINN and Bing lexicons. Words appearing in the NRC lexicon were also excluded (Mohammad & Turney, 2010). The NRC lexicon is not used in this paper as it generates categorical rather than quantitative sentiment assignments, but the presence of a word in the NRC lexicon still indicates that it contains important linguistic information and so should therefore be excluded from the stop word list.

Although all measures will be reported in Section 3.5, 'AFINN/Bing Per Word' is the preferred measure as it provides both an indication of the frequency of word usage as well as the sentiment of word usage. AFINN is preferred to Bing as it provides a classification of the intensity of sentiment as well as the direction of sentiment. The correlation coefficient between the total AFINN score of a debate and the total Bing score is around 0.95.

As with the analysis of Participation, the application of the research design requires that the common trends assumption holds. In this case the common trends assumption would mean that municipalities that adopt IRV would follow the same trend in civility of debates as municipalities that don't adopt IRV.

Visual inspection of the common trends assumption is more difficult with the data used for civility because of the intermittent timing and availability of debate transcripts for treated and control cities. Plotting the average AFINN per word does, however, provide some indication that the common trends assumption may be reasonable. Figure 3.7 shows that treated municipalities are broadly within the same range of AFINN scores over time and that there does not appear to be a divergence between treated and control municipalities. This is true for treated municipalities both before and after they receive treatment.

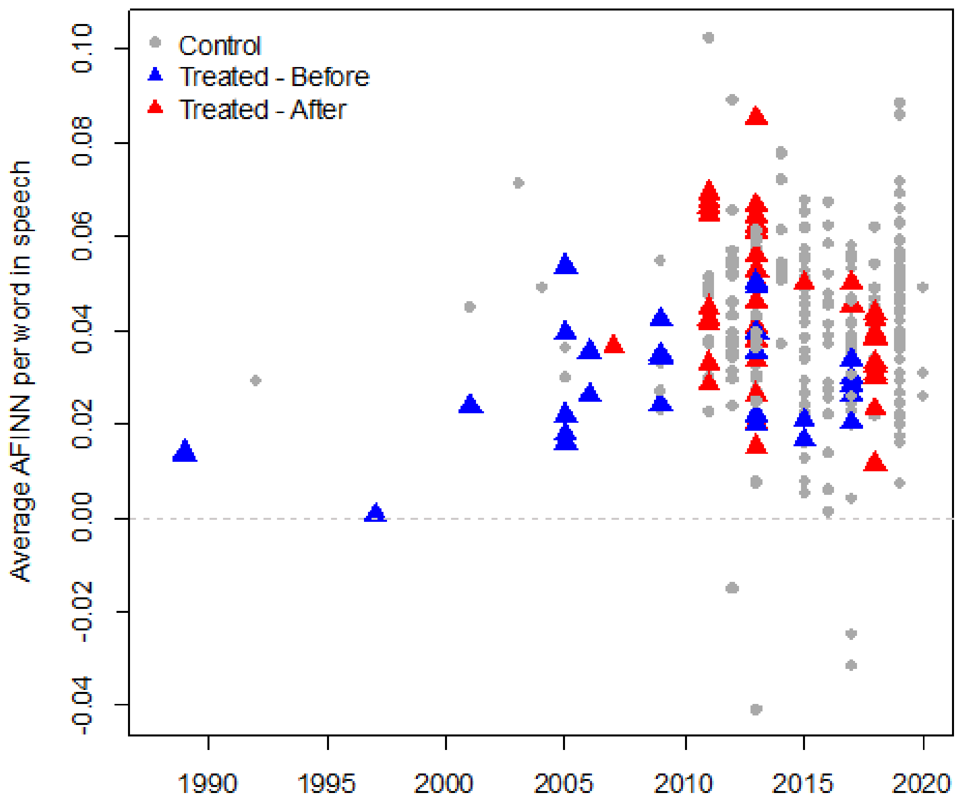


Figure 3.7: Average AFINN per Word in Speeches Over Time for Treated and Control Cities

Source: Author's calculations

It's again possible to graphically see the likely treatment effect in the raw data. As an example, Figure 3.8 shows a simplified case where the data is assigned into 'before' and 'after' groups and only focuses on the cities of Minneapolis and St. Paul in the treated group. Figure 3.8 indicates that the introduction of IRV may have led to an improvement in the sentiment of debates in the Twin Cities, as the AFINN score per word increases and this is counter to the decreasing trend in the control cities. However, the standard errors in this simple example are large, indicating likely challenges in achieving statistical significance if the analysis of civility was limited to the Twin Cities alone in the treated group.

3.5 Main results

3.5.1 Participation

For Participation, there are several sets of results presented below with a range of robustness and specification tests also shown.

For all models presented below, the results are presented using clustered standard errors with the cluster being defined at the municipal level. Clustered standard errors have been used to address issues identified in Bertrand et al. (2004). Clustering at the municipal level allows for the error term to be correlated within a municipality but independent between municipalities. This assumption seems reasonable as turnout within a municipality is not likely to be affected by turnout in other municipalities but there is likely to be some form of correlation over time within the same municipality.

The first table, Table 3.4, presents the main results for participation and shows two alternative models to demonstrate how different model specifications affect the results. Column 1 shows the results when including only year and municipality fixed effects while Column 2 introduces socioeconomic covariates. This results in relatively minor changes to the estimated covariate of interest and no meaningful changes to statistical significance when considering the clustered standard errors. The introduction of covariates does shift the Conley Taber confidence interval so that it excludes zero.

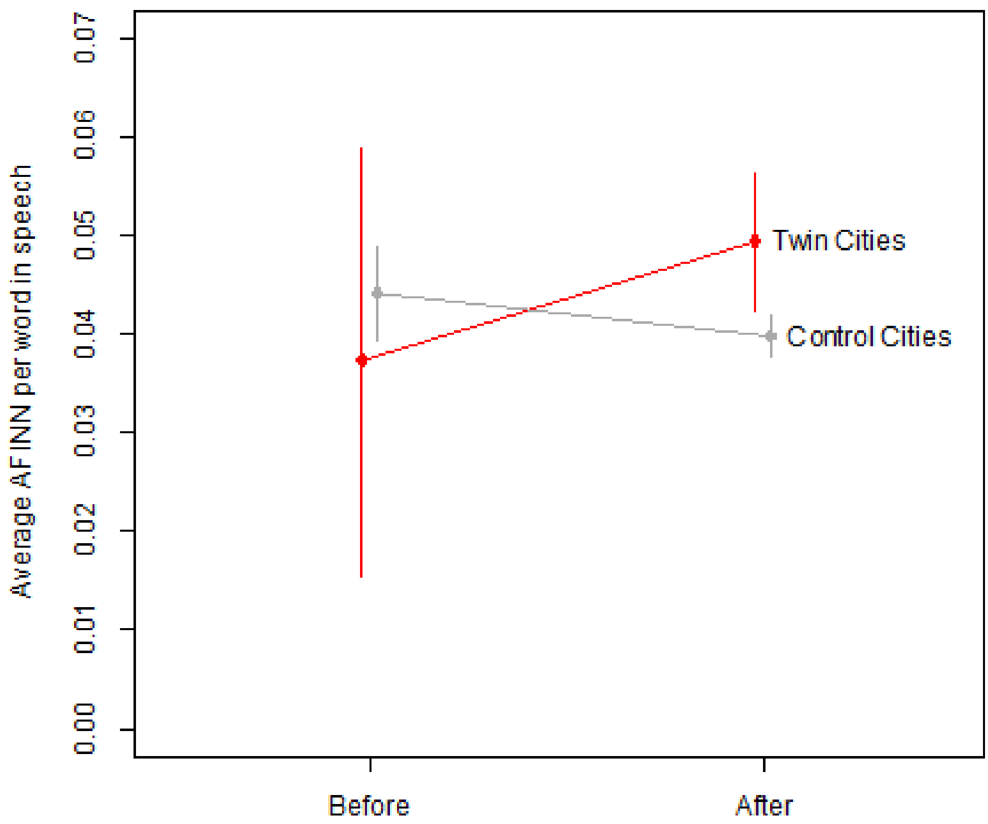


Figure 3.8: Average AFINN per Word in The Twin Cities and Control Cities, Grouped into Before and After
Source: Author's calculations

The parameter estimate for IRV has a straightforward interpretation: its value of 0.096 indicates that the introduction of IRV results in a 9.6 percentage point increase in turnout, on average, while holding other factors constant in Minneapolis and St. Paul mayoral elections. The size of these parameter values suggests significance in practical terms as well as in statistical terms.

Table 3.4: Main results: participation

	Dependent variable: Turnout	
	(1)	(2)
IRV	0.086**	0.096**
	(0.041)	(0.045)
Non-Mayoral Election Dummy	✓	✓
Year FE	✓	✓
Municipality FE	✓	✓
Covariates		✓
Conley-Taber 90% CI	(-0.003, 0.185)	(0.005, 0.197)
Observations	194	194
R^2	0.958	0.962

Note: Data in this regression is aggregated to the municipality level, the level where treatment is applied. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Column 1 shows the results of a basic difference-in-differences regression; Column 2 introduces a range of socioeconomic covariates. Confidence intervals estimated using the approach of Conley & Taber (2011) are reported in the footer of the table.
*p<0.1; **p<0.05; ***p<0.01

As explained in Section 3.4.1, the inclusion of socioeconomic covariates required significant reductions in the data available for the regression due to both difficulties in matching some locations and the limited number of years for which socioeconomic data was available. A further reduction in the data occurs as the results above focus on other municipalities in the Twin Cities as being the relevant control group. These reductions in data could have the potential to affect the estimated treatment effect and the precision with which it is estimated. Table 3.5 reports results at each of the stages of data reduction. Overall, the estimated treatment effect does vary but only changes from around 6.6 percentage points to 9.6 percentage points.

Table 3.5: Effect of Data Reductions on Treatment Effect

	Dependent variable: Turnout				
	FE	Socioeconomic data	+Covariates	Twin Cities	+Covariates
	(1)	(2)	(3)	(4)	(5)
IRV	0.096***	0.066*	0.071*	0.086**	0.096**
	(0.020)	(0.034)	(0.039)	(0.041)	(0.045)
Non-Mayoral Election Dummy	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓	✓
Covariates			✓		✓
Conley-Taber 90% CI	(0.033, 0.206)	(-0.02, 0.176)	(-0.024, 0.176)	(-0.003, 0.185)	(0.005, 0.197)
Observations	611	294	294	194	194
Adjusted R^2	0.899	0.926	0.929	0.958	0.962

Note: Data in this regression is aggregated to the municipality level, which is the level where treatment is applied. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Column 1 shows the results of a basic difference-in-differences regression using the full set of available data at the state level; Column 2 shows the same regression but only using data for which socioeconomic variables are available; Column 3 includes these covariates; Column 4 restricts the data further to only show data for municipalities within the Minneapolis-St. Paul Metro Area; Column 5 introduces a range of socioeconomic covariates. Confidence intervals estimated using the approach of Conley & Taber (2011) are reported in the footer of the table. *p<0.1; **p<0.05; ***p<0.01

Although the data is available at the precinct level, the treatment is applied at the municipal level, which means that the results above are presented at the municipal level. Table 3.6 and Figure 3.9 show versions of the results at the precinct level as well as at the municipal level and verify that aggregation does not result in a major change to the estimated treatment effect. This is unsurprising as the municipal level results should be some weighted average of the precinct level results. However, the fact that the results are similar in nature is useful in the following subgroup analysis as looking at the precinct level data allows for far more variation in the underlying social and economic variables than aggregating up to the municipal level.

A number of subgroups within the data were analyzed using data at the precinct level. The literature review indicated that minorities or at-risk groups (such as those of lower socioeconomic status) may be important in determining the effect of voting policies. Investigation of subgroups based on indicators of food stamp usage and differences in race did not identify any statistically significant differences between groups. Table 3.7 shows the results when splitting the sample depending on poverty rates. The results indicate that areas with higher indicators for poverty saw turnout increase substantially more than areas with lower levels of

Table 3.6: Effect of Geographic Aggregation on Treatment Effect

	Dependent variable: Turnout			
	Precinct level		Municipal level	
	(1)	(2)	(3)	(4)
IRV	0.127***	0.131***	0.086**	0.096**
	(0.049)	(0.047)	(0.041)	(0.045)
Non-Mayoral Election Dummy	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓
Covariates		✓		✓
Conley-Taber 90% CI	(0.061, 0.197)	(0.066, 0.199)	(-0.003, 0.185)	(0.005, 0.197)
Observations	5,850	5,850	194	194
Adjusted R^2	0.904	0.904	0.950	0.953

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level Columns 1 and 3 show the results of a basic difference-in-differences regression; Columns 2 and 4 introduce a range of socioeconomic covariates. Columns 1 and 2 present results where the observation is the (Precinct, Year) pair while Columns 3 and 4 present results where the observation is the (Municipality, Year) pair. A single municipality contains many precincts. Confidence intervals estimated using the approach of Conley & Taber (2011) are reported in the footer of the table. For Columns 1 and 2, the Conley & Taber confidence intervals are calculated using the simulation approach of Proposition 2, due to the large number of treated and control observations. *p<0.1; **p<0.05; ***p<0.01

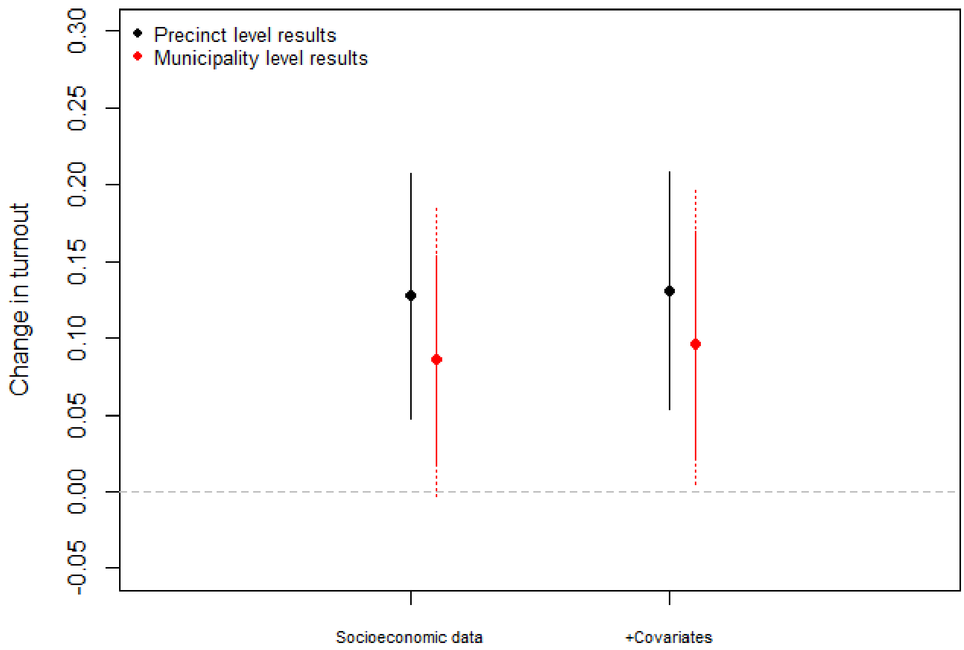


Figure 3.9: Estimated Treatment Effects and Confidence Intervals

Note: Solid lines show 95% confidence intervals using clustered standard errors while dashed lines show 95% confidence intervals using Conley Taber confidence intervals. For the precinct level results, the Conley Taber confidence intervals are smaller than the clustered standard error confidence intervals.
Source: Author's calculations

poverty indicators. This suggests that the introduction of IRV affected turnout particularly strongly for lower income voters.

Table 3.7: Subgroup analysis - Poverty Rates

	Dependent variable: Turnout	
	(Lower Poverty)	(Higher Poverty)
IRV	0.074*	0.243***
	(0.039)	(0.017)
Non-Mayoral Election Dummy	✓	✓
Year FE	✓	✓
Municipality FE	✓	✓
p-value for test of difference		0.000
Average Turnout	66.6	61.8
Observations	1,819	2,853
R^2	0.912	0.912

Note: Data in this regression is at the precinct level. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Data has been split into a 2-quantile. The 'Lower Half' includes precincts with low rates of poverty indicators while the 'Upper Half' includes precincts with high rates of poverty indicators. In Panel B, the uneven number of observations in each column comes about due to allocation of observations with the same observed poverty rates. *p<0.1; **p<0.05; ***p<0.01

The results presented in this section provide evidence that the transition to IRV resulted in an increase in turnout in the Minneapolis-St. Paul Metro Area. Further, the results indicate that the increase in turnout was most prominent in lower income areas.

3.5.2 Civility

For civility, the first two tables show the main results when using the AFINN and Bing lexicons, respectively. The columns in each table are the same and align with the summary statistics reported in Section 3.4.2. In this table, Word Count is the total number of words spoken in a debate, AFINN/Bing Word Count is the number of words spoken that appear in the AFINN/Bing lexicon, AFINN/Bing Total Score is the sum of AFINN/Bing values for all words spoken in the debate, Average AFINN/Bing score is AFINN/Bing Total Score ÷ AFINN/Bing Word Count and AFINN/Bing Per Word is AFINN Total Score ÷ Word Count.

The results in Table 3.8, for AFINN, indicate that the change in the total number of words, the number of words in the AFINN lexicon and the total AFINN score are not statistically significant at conventional levels. There is a statistically significant increase in both the Average AFINN Score (10% level of significance) and AFINN Per Word (5% level of significance). Overall, this indicates that, although the total amount spoken during the debate doesn't change much following the introduction of IRV, there is a statistically significant change in the type of language used following the introduction of IRV. Using Conley-Taber confidence intervals to address the small number of treated units in the data set indicates that the 90% Confidence interval does not include zero for AFINN per word, whic is the preferred measure.

The results indicate that the length of the debates and number of relevant words used remains unchanged while there is an improvement in the rate of positive sentiment words. This leads to an increase in both the average score of words from the lexicon as well as an increase in the average score of each word in the debate. This suggests that the introduction of IRV results in a substitution of negative or neutral words towards more positive words. This provides support for the proposition that the introduction of IRV leads to an improvement in the civility of mayoral debates.

Table 3.8: Main Results – Civility – AFINN

	Dependent variable:				
	Word Count	AFINN Word Count	AFINN Total Score	Average AFINN Score	AFINN Per Word
	(1)	(2)	(3)	(4)	(5)
IRV	4,998.009	557.615	866.205	1.138*	0.079**
	(13,181.570)	(798.810)	(752.079)	(0.591)	(0.039)
Year FE	✓	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓	✓
Covariates	✓	✓	✓	✓	✓
Conley-Taber 90% CI	(-18536.146, 35310.002)	(-902.217, 2250.681)	(-560.202, 2363.529)	(-0.958, 1.983)	(0.004, 0.14)
Observations	156	156	156	156	156
Adjusted R^2	0.124	0.099	0.104	0.171	0.197

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Word Count is the total number of words spoken, AFINN Word Count is the number of words spoken that appear in the AFINN lexicon, AFINN Total Score is the sum of AFINN values for all words spoken, Average AFINN score is (3)÷(2) and AFINN Per Word is (3)÷(1). Covariates are County population and County population over 65. Confidence intervals estimated using the approach of Conley & Taber (2011) are reported in the footer of the table. These are based on the simulation approach of Proposition 2. *p<0.1; **p<0.05; ***p<0.01

The results in Table 3.9, for the Bing lexicon, provide broadly similar results as were seen when using the AFINN lexicon, but statistical significance is not achieved in any measure. An advantage of the Bing lexicon is the ease of interpretting results, noting that the lack of statistical significance reduces the weight that should be placed on this interpretation. The change in Bing Total Score of around +280 indicates a net increase of 280 positive words used per speech. Comparing this to the change in Bing Word Count indicates that speakers are saying about 65 more negative words and 345 more positive words, which results in a ratio of around 84:16.

Table 3.9: Main Results – Civility – Bing

	Dependent variable:				
	Word Count	Bing Word Count	Bing Total Score	Average Bing Score	Bing Per Word
	(1)	(2)	(3)	(4)	(5)
IRV	4,998.009	409.054	279.704	0.468	0.028
	(13,181.570)	(698.689)	(387.290)	(0.365)	(0.017)
Year FE	✓	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓	✓
Covariates	✓	✓	✓	✓	✓
Conley-Taber 90% CI	(-18536.146, 35310.002)	(-876.543, 1862.992)	(-311.652, 978.376)	(-0.115, 0.993)	(-0.001, 0.059)
Observations	156	156	156	156	156
Adjusted R^2	0.124	0.124	0.105	0.083	0.193

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Word Count is the total number of words spoken, Bing Word Count is the number of words spoken that appear in the Bing lexicon, Bing Total Score is the sum of Bing values for all words spoken, Average Bing score is (3)÷(2) and Bing Per Word is (3)÷(1). Covariates are County population and County population over 65. Confidence intervals estimated using the approach of Conley & Taber (2011) are reported in the footer of the table. These are based on the simulation approach of Proposition 2. *p<0.1; **p<0.05; ***p<0.01

The results in this section provide evidence that changing the electoral system to IRV improves the civility of the debate between candidates. The analysis indicates that candidates in IRV elections tended to substitute negative or neutral words for more positive words during the debate. These results align with the previous literature based on voter and candidate surveys and interviews, which generally find perceived improvements from the introduction of IRV.

3.6 Robustness tests

3.6.1 Participation

A range of additional robustness checks were also undertaken. Table 3.10 presents the results of a placebo test where the dependent variable is changed by randomly reallocating treatment across all observations (while holding the total rate of treatment constant). This creates a treatment variable where there is not expected to be a genuine treatment effect and the turnout rate should not, theoretically, be affected by the randomized IRV variable. The treatment is not found to be statistically significant at conventional levels in either specification. This placebo test provides supporting evidence that the treatment effect estimated in the main results is a genuine effect and not a chance result of noise in the data.

Table 3.10: Placebo Test - Participation

	Dependent variable: Turnout	
	(1)	(2)
Randomised IRV	−0.031	−0.028
	(0.034)	(0.034)
Non-Mayoral Election Dummy	✓	✓
Year FE	✓	✓
Municipality FE	✓	✓
Covariates		✓
Observations	194	194
Adjusted R^2	0.949	0.951

Note: Data in this regression is aggregated to the municipality level, which is the level where treatment is applied. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level Column 1 shows the results of a basic difference-in-differences regression; Column 2 introduces a range of socioeconomic covariates. In both data sets, the treatment has been randomly reallocated within the data. *p<0.1; **p<0.05; ***p<0.01

Next, reported in Table 3.11, three alternative model specifications were tested. The first model replaces the single IRV variable with three variables to indicate the year of treatment. This model is to test the possibility that the treatment effect may be due to an initial boost in turnout and not a genuine ongoing effect. The next model uses a lagged dependent variable (LDV) approach. LDV adjusts for pre-treatment outcomes and is considered more appropriate than DID in cases where the common trends assumption does not hold (O'Neill et al., 2016). The last model uses data that has been matched on pre-treatment outcomes[17]. Match-

[17]In particular, the matching is done using the turnout in 2006 and 2008. Matching is carried out using the algorithms provided in Ho et al. (2007) using "full matching," which offers variable numbers of matches in each subclass (Hansen, 2004). The absolute value of the standardised mean difference post matching for

ing on pre-treatment outcomes is another approach that can be used if the parallel trends assumption does not hold. Applying DID to the matched data then allows for control of unobserved time-invariant factors (O'Neill et al., 2016).

Table 3.11: Alternative model specifications

	Dependent variable: Turnout					
	Year of Treatment		Lagged Dependent Variable		Matched on Pre-treatment outcomes	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant			-0.328^{***}			
			(0.102)			
$IRV_{1^{st}}$	0.062^{**}	0.063^{**}				
	(0.026)	(0.029)				
$IRV_{2^{nd}}$	0.099	0.113				
	(0.065)	(0.073)				
$IRV_{3^{rd}}$	0.087^{**}	0.072^{*}				
	(0.036)	(0.039)				
IRV			0.088^{***}	0.115^{***}	0.054	0.056
			(0.034)	(0.042)	(0.034)	(0.037)
Non-Mayoral Election Dummy	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓	✓	✓
Presidential Election FE			✓	✓		
Mid Term FE			✓	✓		
Lagged Outcomes			✓	✓		
Matched Data					✓	✓
Covariates		✓		✓		✓
Observations	194	194	194	194	194	194
Adjusted R^2	0.950	0.952	0.944	0.947	0.976	0.978

Note: Data in this regression is aggregated to the municipality level, which is the level where treatment is applied. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Columns 1 and 2 shows the results of a model that includes dummies for the year of treatment; Columns 3 and 4 show the results of a model that includes lagged dependent variables for 2006 and 2008; Columns 5 and 6 show the results of a model that weights the data to match pre-treatment outcomes. For further information on columns 3-6, please refer to O'Neill et al. (2016). *p<0.1; **p<0.05; ***p<0.01

Columns 1 and 2 of Table 3.11 show that the treatment effect measured in the main results is present when the treatment is broken out by year and and that there doesn't appear to be a strong trend over time. Columns 3 and 4 of Table 3.11 indicate that, after controlling for lagged dependent variables, roughly the same result as in the main results is found (although

pre-treatment outcomes is less than 0.1, which is the rule of thumb for a successful match provided in Flury & Riedwyl (1986) larger and more precisely estimated). Columns 5 and 6 do show the same type of results as the main results – an increase in turnout – but the parameter is not statistically significant at conventional levels. This is likely because the matching algorithm puts very high weight on a small number of observations.

A final check, Table 3.12, corrects for the potential presence of an Ashenfelter dip – whereby the treated units implement IRV to address a decline in voter turnout prior to the policy change (Ashenfelter & Card, 1984). This is unlikely to be the case in this data as the adoption of IRV occurred due to a popular vote and not at the discretion of an individual or small group. Moreover, it was also implemented after a lag of up to 3 years. To correct for the potential presence of an Ashenfelter dip, simple linear models were used to predict turnout at the precinct level for the year 2005 in Minneapolis and 2008 in St. Paul. These models were fitted using data from pre-2005 and pre-2008, respectively, and the predicted values were used to replace the actual turnout values. In general, the predicted values were higher than the actual turnout values.

Table 3.12: Correction for Potential Ashenfelter Dip

	Dependent variable: Turnout	
	(1)	(2)
IRV	0.085**	0.095**
	(0.042)	(0.046)
Non-Mayoral Election Dummy	✓	✓
Year FE	✓	✓
Municipality FE	✓	✓
Covariates		✓
Observations	194	194
Adjusted R^2	0.950	0.953

Note: Data in this regression is aggregated to the municipality level, whic is the level where treatment is applied. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Column 1 shows the results of a basic difference-in-differences regression; Column 2 introduces a range of socioeconomic covariates.
*p<0.1; **p<0.05; ***p<0.01

The results in Table 3.12 are very similar in size and statistical significance to those in the main results, indicating that the role of a potential Ashenfelter dip is not responsible for the results.

The robustness checks presented demonstrate that this finding is stable across a range of model specifications and analysis approaches.

3.6.2 Civility

The following tables focus on providing some additional analysis and robustness checks on the main results above. Table 3.13 shows the effect of introducing socioeconomic covariates. Columns 2 and 4 of Table 3.13 are identical to column 5 in Table 3.8 and Table 3.9, respectively, while Columns 1 and 3 show the same models but do not include the socioeconomic covariates. The results indicate that the addition of these covariates does not result in a change in sign or inference of any of the estimated coefficients. Rather, the covariates lead to an increase in the size of the estimated effect of the introduction of IRV and an increase in the standard error of the estimate. This indicates that the inclusion or exclusion of socioeconomic variables is not fundamental to the nature of the findings but does affect the precise values of parameter estimates.

Table 3.13: Effect of Addition of Covariates on Estimates

	Dependent variable:			
	AFINN Per Word		Bing Per Word	
	(1)	(2)	(3)	(4)
IRV	0.017**	0.079**	0.002	0.028
	(0.008)	(0.039)	(0.003)	(0.017)
Year FE	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓
Covariates		✓		✓
Observations	331	156	331	156
Adjusted R^2	0.227	0.197	0.229	0.193

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Covariates are County population and County population over 65.
*p<0.1; **p<0.05; ***p<0.01

The analysis above uses the AFINN and Bing sentiment lexicons with the preferred results being from the AFINN lexicon. These two lexicons are useful for analysis of political debate as they include words used in general speech rather than being targeted at a particular type of speech. There are, however, a wide range of lexicons available for sentiment analysis, some of which are targeted at financial and economic discussions. Loughran & McDonald (2011) lexicon was developed from a review of words used in 10-K filings and has been used in other analysis of sentiment by economists, such as Shapiro & Wilson (2019), who analyze the sentiment of speeches by the Federal Open Market Committee. Loughran & McDonald compiled their own lexicon as they found that existing lexicons available in 2011 didn't apply satisfactorily to the type of language used in financial discussion. To address this, they reviewed and classified common words used in 10-K filings and demonstrated that this approached produced results with greater predictive power than existing lexicons. Loughran & McDonald's lexicon may not be as suitable for analyzing political speeches as candidates will likely try to convey their message in simple language rather than the technical and audience specific language used in financial statements. However, as a robustness check, Table 3.14 reproduces the main results when using the positive and negative words included in the Loughran & McDonald lexicon (with positive coded as +1 and negative coded as -1 to allow direct comparison to the Bing results in Table 3.9).

Table 3.14: Robustness Check – Civility – Loughran and McDonald Lexicon (L&M)

	Dependent variable:				
	Word Count	L&M Word Count	L&M Total Score	Average L&M Score	L&M Per Word
	(1)	(2)	(3)	(4)	(5)
IRV	4,998.009	223.838***	112.625***	0.933*	0.020
	(13,181.570)	(31.400)	(20.329)	(0.511)	(0.016)
Year FE	✓	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓	✓
Covariates	✓	✓	✓	✓	✓
Conley-Taber 90% CI	(-18536.146, 35310.002)	(-600.232, 789.071)	(-85.916, 407.476)	(-0.204, 1.791)	(-0.006, 0.041)
Observations	156	156	156	156	156
Adjusted R^2	0.124	0.113	0.268	0.145	0.137

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Word Count is the total number of words spoken, LM Word Count is the number of words spoken that appear in the Loughran & McDonald (2011) lexicon, LM Total Score is the sum of LM values for all words spoken, Average LM score is (3)÷(2) and LM Per Word is (3)÷(1). Covariates are County population and County population over 65. Confidence intervals estimated using the approach of Conley & Taber (2011) are reported in the footer of the table. These are based on the simulation approach of Proposition 2.
*p<0.1; **p<0.05; ***p<0.01

Overall, the results are more statistically significant than seen in the results when using either the AFINN or the Bing lexicons and the sign and magnitude of the coefficients are similar. All of the Conley Taber confidence intervals do, however, include zero, indicating that the inference is not robust to accounting for the small number of treated units in the analysis. These results indicate that the nature of the results isn't wholly a result of the particular lexicon used for the analysis and that the results are seen even when using more audience specific lexicons.

Table 3.15, below, presents the results of a placebo test. In this analysis, Column 1 shows the results where the dependent variable is the number of stop words used in a debate. Stop words are common English language words that do not convey much topical information but are important for sentence construction. They include words such as 'those', 'into', 'the' and 'now'. The initial stop word database was sourced from Silge & Robinson (2016) but was adjusted to remove any words appearing in the AFINN, Bing and NRC lexicons. This was done to ensure that words relevant to the results in Table 3.8 and Table 3.9 were not included in the placebo test. As the remaining stop words are frequently used to construct English sentences regardless of the context, it should be the case the frequency of their use should not be affected by the introduction of IRV.

The other columns of Table 3.15 show results when the dependent variable is set to be the rate of usage of particular words that, intuitively, shouldn't be affected by the introduction of IRV. For example, the dependent variable in Column 2 is the rate at which the word 'mayoral' is used within a debate. These words were selected based on the manual review of 2013 Minneapolis debates as words that were likely to appear in debates but which, on their own, do not necessarily contain any positive or negative intention. For each of Columns 1 to 5, the IRV variable is not statistically significant at conventional levels, indicating that the introduction of IRV did not result in a change in the frequency of the use of that particular word. This gives support to the earlier results by providing some evidence that the effect is not the results of noise in the data or a random occurrence.

Table 3.15: Placebo Test – Sentiment Analysis

	Dependent variable:		
	Stop Word Rate	'Mayoral' Rate	'Voter' Rate
	(1)	(2)	(3)
IRV	0.001	0.001	−0.001
	(0.115)	(0.001)	(0.001)
Year FE	✓	✓	✓
Municipality FE	✓	✓	✓
Covariates	✓	✓	✓
Observations	156	156	156
Adjusted R^2	−0.156	0.167	0.273

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the municipality level. Stop Words Rate is defined as the number of words appearing in a standard list of common English language words – based on a database compiled by Silge & Robinson (2016) – divided by the total number of words spoken. Covariates are County population and County population over 65.
$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

3.7 Conclusion

In recent years, IRV has seen a resurgence in use in a number of metropolitan areas in the U.S. Proponents of IRV have claimed a range of benefits including: ensuring majority support, reducing costs, increasing civility, reducing conflict, reducing strategic effects and increasing diversity. These direct benefits have also been expected to translate into an increase in voter turnout.

A sizable literature has developed analyzing the various purported benefits of IRV and there is mounting evidence that IRV has not been living up to expectations in many areas. This paper focuses on two particular areas of potential benefit of IRV that have mixed results and weak methodologies in the existing literature: increasing turnout and improving civility.

For turnout, this paper focuses on a DID research design limited to the Twin Cities Metropolitan Area. Limiting analysis to the Twin Cities Metropolitan Area helps ensure that the common trends assumption underlying the DID approach is likely to be supported. This approach is in contrast to previous papers that have not had a clear research design or, when they do, they look at a broad range of treated cities without a clear motivation for establishing the control group. The results of the analysis indicate that, in the Minneapolis-St. Paul Metro Area, the introduction of IRV caused a 9.6 percentage point increase in turnout, on average. This result is statistically significant at conventional levels using clustered standard errors and 90% Conley-Taber confidence intervals that exclude zero. The effect on turnout is larger for precincts that have higher poverty rates.

For civility, previous research has essentially used surveys or interviews whereas new techniques based on natural language processing allow for a more precise quantification of the effect of IRV on civility during campaigns. Analysis of the sentiment of language used during mayoral debates indicates that the introduction of IRV improved the civility of debates. The improvement in civility is due to candidates substituting negative or neutral words for more positive words throughout the debate.

The findings on turnout could be extended by applying a similar DID approach in other cities that have both a long history of IRV and staggered geographic introduction (San Francisco, for example) in order to determine whether Minneapolis and St. Paul present an unusual case[18] or whether the results here have external validity. Analysis of civility will naturally improve over time as more debates are recorded and transcribed on the internet. The text-as-data approach also opens up the possibility for analyzing the effect of IRV on other outcomes, such as the topic discussed in debates and whether winners of IRV elections speak differently than winners of FPTP elections. These questions require different methodologies than what is used in this paper[19].

The positive findings in this paper indicate that the introduction of IRV is performing better than the previous literature would suggest. To the extent that turnout can be seen as a barometer of the overall value of a vote (Downs, 1957), these results also suggest that IRV is having a positive effect on the perceived value of voting to the voter.

In practice, these findings suggest that there is genuine value being created by the recent increase in municipalities using IRV, and also provides evidence of additional benefits for municipalities that are considering changing their electoral system. Perhaps the benefits are enough to alter the cost-benefit calculation for politicians and voters who are weighing up a change to IRV.

[18] For example, using a structural model, Kawai et al. (2020) estimate that Minnesota has the highest level of perceived efficacy of voting among all U.S. states. In contrast, California has the 5th lowest levels of perceived efficacy of voting among the states.

[19] The appropriate methodologies are explained in Gentzkow et al. (2019a).

4

Concluding Remarks

In Chapter 1, on informal voting in Australian elections, I find that factors that feature in the traditional theory on voter decisions, competitiveness and the number of other voters, do not affect the rate of informal voting. Instead I find that more candidates on the ballot results in higher levels of informal voting. A back of the envelope calculation indicates that, if the number of options on each ballot were reduced by half then the total number of observed informal votes in the data would be reduced by 27%, and the share of informal votes would fall from 5.4% in total to 3.9%.[1] This effect is important because, from 2004-2016, around 32% of contests had more informal votes than the margin. Policies which affect the level of

[1] This back of the envelope calculation does not take into account other effects that would likely happen in a real world situation where the number of candidates halved, such as changes in the political positions of the candidates or their electoral strategies.

informal voting may, therefore, affect the final composition of Parliament. The implication of these findings is to make it simpler for voters to complete their ballot by, for example, not requiring a complete ranking of all candidates on the ballot.

Chapter 2, on debates around Same Sex Marriage, shows that, in this case at least, personal ideology, not the position of the electorate, plays a large role in determining political speech. In particular, Opposers of SSM tended to become stronger in their opposition to SSM once the results of the SSM national survey were released – the average Opposer increased their opposition by 0.15-0.2 on a scale of 0-1. This strengthening of opposition occurred regardless of the position of their electorate. No consistent and statistically significant change is seen in the behavior of Supporters of SSM. This result suggests that personal ideology systematically affected politician's behavior.

The results suggest that the purported 'treatment' offered by a national survey, where different politicians would be exposed to different levels of support or opposition to SSM from their electorate did not actually have any effect. Rather, the actual 'treatment' was created by the overall process of running the survey. In practice, this suggests that running similar non-binding surveys in the future likely won't be effective at changing the behavior of politicians to align with their electorate.

Chapter 3, on the transition to instant run-off voting (IRV) in the U.S., shows that, in the Minneapolis-St. Paul Metro Area, the introduction of IRV caused a 9.6 percentage point increase in turnout for mayoral elections. Also, in mayoral debates in a broader set of cities across the U.S., the introduction of IRV improved the civility of debates. The improvement in civility is due to candidates substituting negative or neutral words for more positive words throughout the debate. In practice, this suggests that adoption of IRV could be one way to increase voter participation and also enhance civility in political debate.

These findings suggest a number of potential directions for further research. The results on informal voting could be extended through application of a similar research design to elections held under a voluntary voting regime, such as in the United States, this would confirm whether the results have external validity or whether they are restricted to Australia's voting system. Further, as time, and another election, have elapsed since the Same Sex Marriage debate, there is the possibility of analyzing whether voters punished representatives who acted against their wishes. Finally, the results on IRV will naturally be able to be improved as additional footage of mayoral debates is put online and can be analyzed. The findings on turnout could be extended by applying a similar DID approach in other cities that have both a long history of IRV and staggered geographic introduction (San Francisco, for example) in order to determine whether Minneapolis and St. Paul present an unusual case.

Combining ideas from the different chapters also presents some options. The text-as-data approach used in the Same Sex Marriage analysis could be applied to analyzing the effect of IRV on outcomes such as the topic discussed in debates and whether winners of IRV elections talk differently to winners of FPTP elections.

Finally, the results for IRV show that its introduction increases turnout but the results for informal voting show that too many options increases informal voting – together this suggests that there may be an 'optimal' number of options on the ballot. This could potentially be investigated by comparing different IRV locations in the U.S. that operate using different technologies which imposes plausibly exogenous limits on the number of options that can be selected.

More broadly, the findings also have general implications for the type of features needed in a theory of voters and politicians that can have power in explaining behavior. The results indicate that voters and politicians are affected by a very broad range of factors that include mental processing costs, personal ideology and the type of voting system being used. These are not directly related to the core of basic economic models of voter or politician behavior, which largely focus on benefits of having a preferred policy implemented, and they indicate some of the many facets that are needed to fully understand and model voter and politician behavior.

A

Distributions of some variables of interest

This appendix includes some visualisations of key variables of interest from Chapter 1. A number of kernel density plots for the level of informal voting are shown in Figure A.1, below. The lower level of informal voting in 2007 is noteworthy, a potential explanation for this is that the 2007 election saw a long serving government replaced by a new government and so voter's may have been more interested and engaged in the 2007 election than other elections, however the 2013 election also saw a change in government without an associated reduction in informality.

The distribution of electoral division sizes over time in shown in Figure A.2. The figure shows that the size of electoral divisions has been increasing over time, associated with population

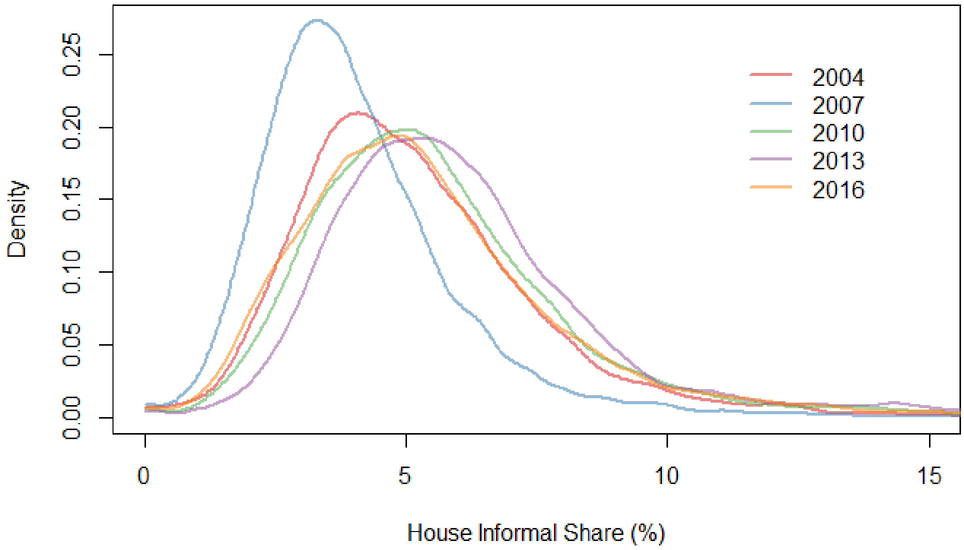


Figure A.1: Informal Vote Share in House

growth.

The distribution of the number of options in the House of Representatives is shown in Figure A.3.

Kernel density estimates for the margin are shown in Figure A.4, these demonstrate a consistency in the distribution of margin over time.

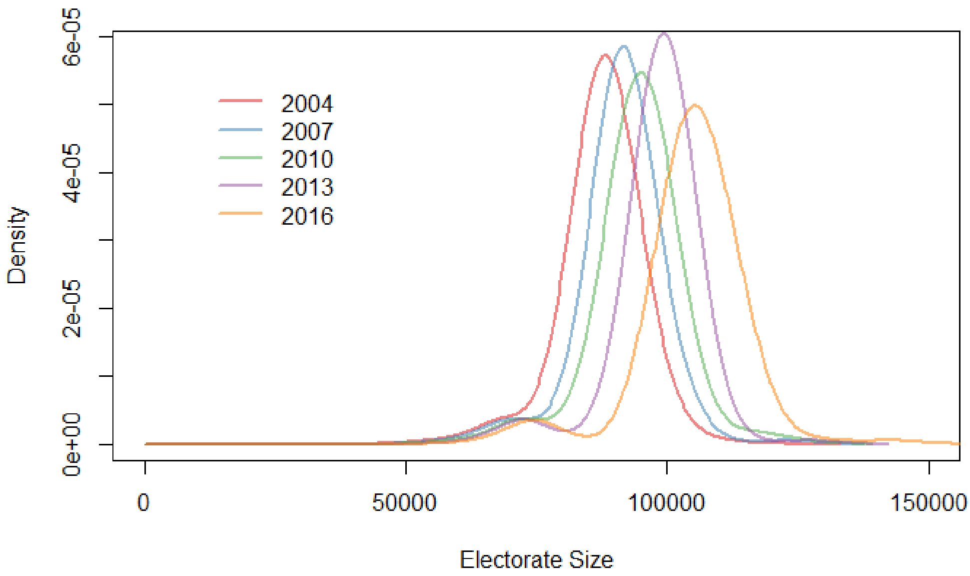


Figure A.2: Electoral Division Size

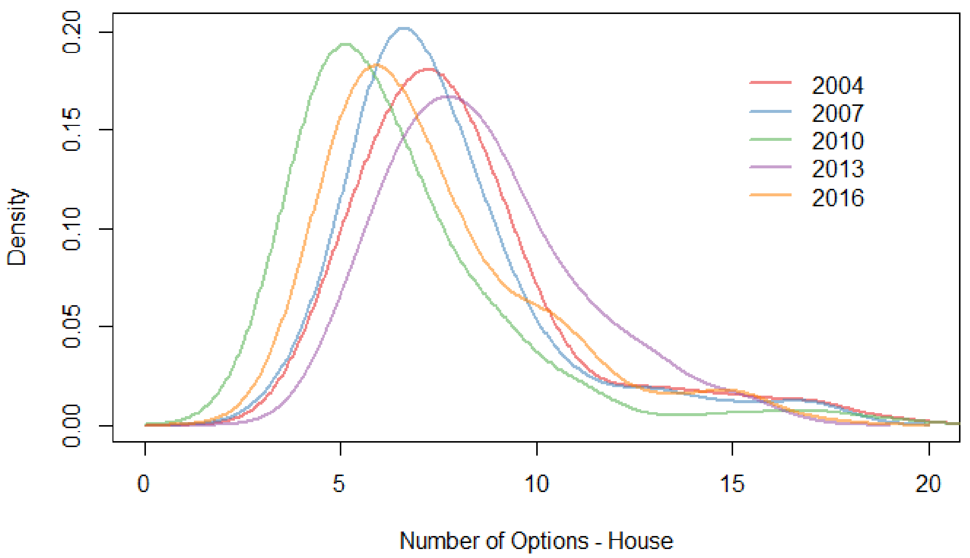


Figure A.3: Number of Options in House

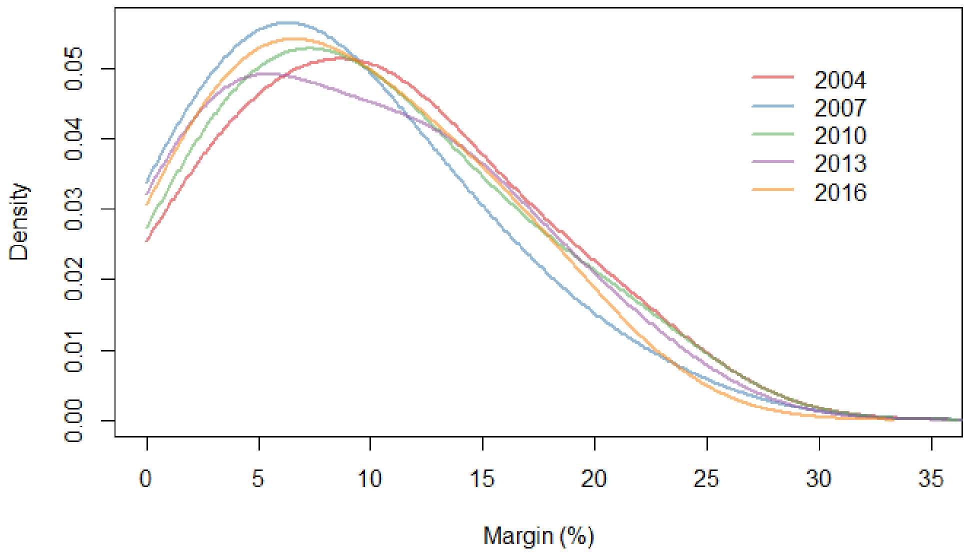


Figure A.4: Margin

B

Detailed model outputs

This appendix includes full regression results for all results reported in the main body of Chapter 1.

Table B.1, sets out the results of a first stage regression where, in Column 1, the dependent variable is whether a polling place changed division and, in Column 2, whether the polling place is in an electorate that changed division. If this treatment indicator could be easily predicted by observable characteristics then the research design may be problematic. The results indicate that observable characteristics are often not strongly associated with treatment and that, overall, the regression has low explanatory power, as measured by adjusted R^2. This supports use of the proposed research design and treating the change in electorate boundaries as a exogenous change.

Table B.1: First Stage Regressions

	Dependent variable:	
	Polling Place Changed Division	Division had Polling Place change
	(1)	(2)
Median Age	-0.001^{**}	-0.006^{***}
	(0.0004)	(0.001)
Mean Income (000)	-0.00000	-0.0001
	(0.0002)	(0.0003)
Unemployment (%)	-0.002^{*}	0.010^{***}
	(0.001)	(0.002)
Population Density	0.00000	0.00000
	(0.00000)	(0.00000)
Population Growth (%)	0.0004	0.006^{***}
	(0.001)	(0.002)
Population Decline (%)	0.002^{***}	0.004^{***}
	(0.001)	(0.001)
House value (000)	0.00000	0.00002^{***}
	(0.00000)	(0.00001)
English 2nd Language (%)	0.001^{***}	0.0004
	(0.0001)	(0.0003)
Tertiary degree (%)	-0.002^{***}	-0.003^{***}
	(0.0003)	(0.001)
Constant	0.141^{***}	0.562^{***}
	(0.019)	(0.036)
Observations	23,476	23,476
Adjusted R^2	0.008	0.011

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Results in the first column for 'Polling Place Changed Division' are for a linear probability model where the dependent variable is equal to one if that Polling Place changed division in a given year. Results in the second column for 'Electoral division had Polling Place change' are for a linear probability model where the dependent variable is equal to one if that Polling Place was in an electoral division where any Polling Places changed division in a given year. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table B.2 presents the main results of the analysis but also includes parameters estimates for all covariates except Polling Place fixed effects.

Tables B.3-B.5 show alternative versions of the main results that both include alternative con-

Table B.2: Main Results – Full Version

	Dependent variable: Informal %					
	Model specifications					
	OLS	OLS w. covariates	Fixed Effects	DID Standard	DID Propensity Score Matched	DID Distance Limited
	(1)	(2)	(3)	(4)	(5)	(6)
Margin	2.177***	−0.217	−3.195***	−3.404***	−5.280***	−5.450***
	(0.345)	(0.283)	(0.356)	(0.367)	(0.610)	(0.633)
ln(Voters)	3.534***	1.387***	0.837**	0.975***	3.265***	0.571
	(0.192)	(0.156)	(0.351)	(0.361)	(0.604)	(0.601)
ln(N Options)	0.468***	0.858***	2.079***	2.056***	2.176***	1.744***
	(0.067)	(0.053)	(0.057)	(0.057)	(0.097)	(0.112)
Change in Margin				−2.232**	−3.486***	−3.217***
				(0.891)	(1.042)	(0.915)
Change in ln(Voters)				−0.881	−0.575	−0.161
				(1.107)	(1.362)	(1.161)
Change in ln(N Options)				2.380***	2.508***	2.209***
				(0.205)	(0.263)	(0.209)
Changed Division				−0.298***	−0.446***	−0.215***
				(0.065)	(0.092)	(0.065)
2010		1.602***	2.093***	2.081***	2.234***	2.333***
		(0.029)	(0.039)	(0.039)	(0.071)	(0.073)
2013		1.602***	2.046***	2.014***	1.944***	2.841***
		(0.041)	(0.073)	(0.073)	(0.134)	(0.136)
2016		0.777***	1.763***	1.733***	1.510***	2.155***
		(0.051)	(0.098)	(0.099)	(0.178)	(0.179)
Median Age		−0.032***	−0.010	−0.008	−0.007	0.105***
		(0.004)	(0.015)	(0.015)	(0.026)	(0.027)
Mean Income (000)		0.021***	−0.016***	−0.016***	−0.011	−0.042***
		(0.002)	(0.004)	(0.004)	(0.007)	(0.007)
Unemployment (%)		0.127***	−0.127	−0.133	−0.752**	−0.100
		(0.012)	(0.188)	(0.189)	(0.315)	(0.421)
Population Density		0.0002***	0.00003	0.00003	0.0002	0.0002
		(0.00003)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Population Growth (%)		−0.023**	0.001	0.002	0.025*	0.032*
		(0.009)	(0.011)	(0.011)	(0.015)	(0.017)
Population Decline (%)		0.014**	−0.004	−0.004	0.023*	0.006
		(0.007)	(0.008)	(0.007)	(0.013)	(0.012)
House Value (000)		0.0001***	−0.00003	−0.00003	0.0001	−0.00004
		(0.00003)	(0.00002)	(0.00002)	(0.0001)	(0.00003)
English 2nd Language (%)		0.071***	−0.063***	−0.064***	−0.066***	−0.060***
		(0.003)	(0.013)	(0.013)	(0.021)	(0.018)
Tertiary Degree (%)		−0.129***	0.038	0.028	0.050	0.093
		(0.003)	(0.075)	(0.074)	(0.112)	(0.101)
Constant	−36.408***	−12.874***				
	(2.151)	(1.764)				
Polling Place FE			✓	✓	✓	✓
Clusters (Polling Place)	5,930	5,930	5,930	5,930	4,195	1,955
Observations (Polling Place × Year)	23,096	23,096	23,096	23,096	11,677	7,483
Treated Observations	NA	NA	NA	1,415	1,063	1,415
Control Observations	NA	NA	NA	21,681	10,614	6,068
R^2	0.030	0.432	0.354	0.356	0.378	0.413

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Time period fixed effects use 2007 as the reference year. R^2 for FE models is the unadjusted 'within' R^2 *p<0.1; **p<0.05; ***p<0.01

trol group (Columns 4 and 5) and different model specifications (Tables B.4 and B.5). The alternative control groups are used to test whether the fact that control booths in the main result receive some form of treatment has any effect on the overall results. Table B.4 and B.5 present alternative model specifications that include voting in the Senate as a form of control group. Senate voting is not affected by changes in electorate boundaries and so can potentially form a control for voting in the House of Representatives. However there are important differences between voting in both Houses that makes the Senate less preferable control group. Despite this, the findings are broadly consistent across all columns in Tables B.3-B.5.

Table B.6 and B.7 present the results of further robustness checks – a placebo test – where the dependent variable is changed to variables where there is not expected to be a genuine treatment effect. The variables that have been selected are related to the election process but should not, theoretically, be affected by the number of options available on the ballot, the number of voters in the electoral division or the margin in the electoral division. In particular, Column 1 and Column 2 report the results of a model where the dependent variables are the total number of votes recorded in the House of Representatives and Senate respectively – due to compulsory voting in Australia, this shouldn't be directly affected by political conditions. Columns 3, 4, and 5 focus on outcomes in the Senate. Column 3 focuses on the percent of informal votes in the Senate, Column 4 focuses on the percent of Donkey votes in the Senate while Column 5 looks at the share of votes for non-major parties (i.e. not Liberal, National, Labor or the Greens). In this case, Donkey voting is defined as when a voter votes for the first party on the ballot as their first preference. Each of these outcomes should not be affected by changes in the number of options, voters or margin in the House of Representatives.

Table B.8 and B.9 present results when the data is subset according to quartiles of tertiary education. For the highest education group (Quartile 4), informal votes are less prevalent, the sign for *Change in ln(Options)* and *Change in Margin* are in line with the implications of the hypotheses, and are statistically significant.

Table B.10 present a version of the main results where two additional variables that could potentially affect informal voting are included. These are the tenure (in years) of the incumbent

Table B.3: Alternative Model Specifications – Panel A DID v1 (House, Treated and Control Polling Places)

	Dependent variable: Informal %				
	Model specifications				
	Standard	Propensity Score Matched	Distance Limited	Controls are non-treated divisions	Treated divisions only
	(1)	(2)	(3)	(4)	(5)
Margin	-3.404^{***}	-5.280^{***}	-5.450^{***}	-2.042^{***}	-8.760^{***}
	(0.367)	(0.610)	(0.633)	(0.492)	(1.019)
ln(Voters)	0.975^{***}	3.265^{***}	0.571	3.274^{***}	-6.293^{***}
	(0.361)	(0.604)	(0.601)	(0.500)	(0.994)
ln(N Options)	2.056^{***}	2.176^{***}	1.744^{***}	2.308^{***}	1.509^{***}
	(0.057)	(0.097)	(0.112)	(0.077)	(0.158)
Change in Margin	-2.232^{**}	-3.486^{***}	-3.217^{***}	-1.784^{*}	-4.815^{***}
	(0.891)	(1.042)	(0.915)	(0.985)	(1.219)
Change in ln(Voters)	−0.881	−0.575	−0.161	−0.714	-5.576^{***}
	(1.107)	(1.362)	(1.161)	(1.240)	(1.826)
Change in ln(N Options)	2.380^{***}	2.508^{***}	2.209^{***}	2.478^{***}	2.121^{***}
	(0.205)	(0.263)	(0.209)	(0.228)	(0.283)
Changed Division	-0.298^{***}	-0.446^{***}	-0.215^{***}	-0.459^{***}	−0.026
	(0.065)	(0.092)	(0.065)	(0.075)	(0.110)
2010	2.081^{***}	2.234^{***}	2.333^{***}	1.904^{***}	2.532^{***}
	(0.039)	(0.071)	(0.073)	(0.052)	(0.098)
2013	2.014^{***}	1.944^{***}	2.841^{***}	1.698^{***}	
	(0.073)	(0.134)	(0.136)	(0.098)	
2016	1.733^{***}	1.510^{***}	2.155^{***}	1.450^{***}	2.855^{***}
	(0.099)	(0.178)	(0.179)	(0.127)	(0.308)
Median Age	−0.008	−0.007	0.105^{***}	0.017	0.057
	(0.015)	(0.026)	(0.027)	(0.019)	(0.046)
Mean Income (000)	-0.016^{***}	−0.011	-0.042^{***}	-0.018^{***}	−0.005
	(0.004)	(0.007)	(0.007)	(0.005)	(0.009)
Unemployment (%)	−0.133	-0.752^{**}	−0.100	−0.109	−0.188
	(0.189)	(0.315)	(0.421)	(0.232)	(0.484)
Population Density	0.00003	0.0002	0.0002	−0.00003	−0.0001
	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
Population Growth (%)	0.002	0.025^{*}	0.032^{*}	0.003	0.025
	(0.011)	(0.015)	(0.017)	(0.017)	(0.023)
Population Decline (%)	−0.004	0.023^{*}	0.006	−0.004	−0.005
	(0.007)	(0.013)	(0.012)	(0.010)	(0.014)
House Value (000)	−0.00003	0.0001	−0.00004	−0.00001	-0.0001^{**}
	(0.00002)	(0.0001)	(0.00003)	(0.00004)	(0.0001)
English 2nd Language (%)	-0.064^{***}	-0.066^{***}	-0.060^{***}	-0.079^{***}	−0.018
	(0.013)	(0.021)	(0.018)	(0.018)	(0.030)
Tertiary Degree (%)	0.028	0.050	0.093	0.141	-0.443^{**}
	(0.074)	(0.112)	(0.101)	(0.096)	(0.186)
Polling Place FE	✓	✓	✓	✓	✓
Observations (Polling Place × Year)	23,096	11,677	7,483	15,534	6,130
R^2	0.356	0.378	0.413	0.394	0.383

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Time period fixed effects use 2007 as the reference year. Propensity score matching is not applied to columns 1, 3, 4 or 5. R^2 for FE models is the unadjusted 'within' R^2 $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table B.4: Alternative Model Specifications – PANEL B – DID V2 (House and Senate, Treated Polling Places Only)

	Dependent variable: Informal %				
	Model specifications				
	Standard	Propensity Score Matched	Distance Limited	Controls are non-treated divisions	Treated divisions only
	(1)	(2)	(3)	(4)	(5)
Change in Margin			1.045		
			(0.947)		
Change in ln(Voters)			0.098		
			(1.253)		
Change in ln(N Options)			1.709***		
			(0.218)		
Polling Place × Year FE			✓		
Observations (Polling Place × Year × House)			2,830		
R^2			0.356		

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Time period fixed effects use 2007 as the reference year. R^2 for FE models is the unadjusted 'within' R^2 *p<0.1; **p<0.05; ***p<0.01

candidate and the share of votes for progressive parties (defined as first preference votes for the ALP and Green parties). Similarly as for other variables, logs and differences are then applied to the tenure variable. These variables could potentially affect informal voting as, for example, voters who are moved into an electoral division where there is a strong incumbent candidate may not see value in voting while voters that move into an area with a strong (or weak) progressive voter base may also not see much value in casting a valid vote.

Table B.11 presents a version of the main results where the margin is defined as the margin measure on first preferences (that is the number one preference on the ballots when submitted). This is important because of the complexity of defining and understanding the margin in an Instant Runoff Voting system – as is used in the House of Representatives in Australia. In this system, the margin is defined based on the share of votes in the final round of voting not on the share of first preference votes. This may make it more difficult for voters to understand and respond to the expected margin when placing their vote (as it requires some calculation of the flow of preferences throughout the runoff process).

Table B.5: Alternative Model Specifications – PANEL C – DDD (House ans Senate, Treated and Control Polling Places)

	Dependent variable: Informal %				
	Model specifications				
	Standard	Propensity Score Matched	Distance Limited	Controls are non-treated divisions	Treated divisions only
	(1)	(2)	(3)	(4)	(5)
Margin	−1.721***	−3.025***	−3.453***	−0.585*	−5.313***
	(0.249)	(0.393)	(0.413)	(0.327)	(0.617)
ln(Voters)	1.587***	3.316***	1.641***	2.969***	−2.618***
	(0.248)	(0.404)	(0.399)	(0.339)	(0.593)
ln(N Options)	0.964***	1.009***	0.721***	1.117***	0.598***
	(0.039)	(0.062)	(0.071)	(0.051)	(0.094)
Change in Margin	−0.057	−0.736	−0.969	0.457	−1.404
	(0.741)	(0.814)	(0.734)	(0.751)	(0.943)
Change in ln(Voters)	−0.062	0.724	0.373	0.141	−2.011
	(0.888)	(1.014)	(0.910)	(0.921)	(1.290)
Change in ln(N Options)	1.922***	1.955***	1.836***	1.950***	1.811***
	(0.182)	(0.202)	(0.176)	(0.182)	(0.220)
Changed Division	−0.136***	−0.220***	−0.090**	−0.219***	−0.043
	(0.043)	(0.057)	(0.043)	(0.046)	(0.068)
House	1.754***	1.880***	2.168***	1.623***	1.966***
	(0.018)	(0.028)	(0.039)	(0.021)	(0.028)
2010	1.662***	1.860***	1.957***	1.416***	2.291***
	(0.028)	(0.048)	(0.052)	(0.036)	(0.062)
2013	1.273***	1.272***	1.906***	0.921***	
	(0.050)	(0.087)	(0.092)	(0.065)	
2016	1.598***	1.548***	1.997***	1.248***	2.818***
	(0.067)	(0.117)	(0.122)	(0.085)	(0.190)
Median Age	0.010	0.003	0.090***	0.033***	0.004
	(0.010)	(0.017)	(0.019)	(0.013)	(0.028)
Mean Income (000)	−0.014***	−0.011**	−0.035***	−0.010***	−0.015***
	(0.002)	(0.005)	(0.005)	(0.003)	(0.006)
Unemployment (%)	−0.087	−0.358*	0.223	−0.089	−0.086
	(0.129)	(0.208)	(0.282)	(0.148)	(0.321)
Population Density	−0.0001	0.00001	0.0001	−0.0001*	−0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Population Growth (%)	0.013*	0.024**	0.038***	0.012	0.020
	(0.007)	(0.009)	(0.011)	(0.011)	(0.014)
Population Decline (%)	−0.001	0.015*	0.010	−0.001	0.001
	(0.005)	(0.009)	(0.008)	(0.007)	(0.009)
House Value (000)	−0.00004**	0.00004	−0.00004**	−0.00004	−0.0002***
	(0.00002)	(0.0001)	(0.00002)	(0.00003)	(0.0001)
English 2nd Language (%)	−0.031***	−0.028**	−0.030***	−0.042***	−0.005
	(0.008)	(0.013)	(0.012)	(0.011)	(0.018)
Tertiary Degree (%)	−0.013	−0.005	0.043	0.055	−0.281**
	(0.048)	(0.069)	(0.071)	(0.063)	(0.125)
Polling Place FE	✓	✓	✓	✓	✓
Observations (Polling Place × Year × House)	46,192	23,343	14,966	31,068	12,260
R^2	0.412	0.427	0.466	0.396	0.551

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Time period fixed effects use 2007 as the reference year. Propensity score matching is not applied to columns 1, 3, 4 or 5. R^2 for FE models is the unadjusted 'within' R^2 *p<0.1; **p<0.05; ***p<0.01

Table B.6: Placebo Test - Panel A - Standard

	Dependent variable:				
	Total House Votes	Total Senate Votes	Senate Informal %	Senate Donkey %	Senate Other %
	(1)	(2)	(3)	(4)	(5)
Margin	145.405**	145.003**	−0.002	−0.014**	−0.025**
	(58.783)	(58.846)	(0.003)	(0.006)	(0.010)
ln(Voters)	336.182***	331.455***	0.022***	0.108***	−0.099***
	(73.709)	(73.817)	(0.003)	(0.008)	(0.012)
ln(N Options)	−7.838	−7.620	−0.001**	−0.005***	−0.032***
	(9.754)	(9.771)	(0.0004)	(0.001)	(0.002)
Change in Margin	44.420	40.872	0.005	−0.007	−0.003
	(123.432)	(123.053)	(0.007)	(0.006)	(0.022)
Change in ln(Voters)	87.800	84.700	0.005	0.083***	0.050*
	(181.312)	(180.780)	(0.008)	(0.009)	(0.030)
Change in ln(N Options)	14.363	14.080	−0.001	−0.002	−0.020***
	(24.340)	(24.318)	(0.002)	(0.001)	(0.005)
Changed Division	8.223	8.396	0.0004	−0.0005	−0.012***
	(10.190)	(10.196)	(0.0004)	(0.0005)	(0.002)
2010	−108.672***	−109.032***	0.013***	0.001***	0.019***
	(7.745)	(7.774)	(0.0003)	(0.001)	(0.001)
2013	−284.915***	−285.095***	0.005***	0.003***	0.156***
	(17.199)	(17.231)	(0.001)	(0.001)	(0.002)
2016	−307.475***	−306.943***	0.015***	−0.013***	0.197***
	(23.337)	(23.386)	(0.001)	(0.002)	(0.003)
Median Age	9.277***	9.306***	0.0003***	−0.002***	0.005***
	(3.068)	(3.074)	(0.0001)	(0.0003)	(0.0004)
Mean Income (000)	4.976***	4.961***	−0.0001***	−0.0004***	−0.002***
	(0.860)	(0.863)	(0.00003)	(0.0001)	(0.0001)
Unemployment (%)	−11.513	−11.123	−0.0004	0.003	−0.008
	(24.446)	(24.460)	(0.001)	(0.002)	(0.005)
Population Density	0.025*	0.025*	−0.00000***	−0.00000***	−0.00001***
	(0.014)	(0.014)	(0.00000)	(0.00000)	(0.00000)
Population Growth (%)	4.869*	4.963*	0.0002***	0.001***	0.001***
	(2.790)	(2.799)	(0.0001)	(0.0002)	(0.0003)
Population Decline (%)	−1.935	−1.903	0.00001	0.001***	−0.001***
	(1.800)	(1.799)	(0.00005)	(0.0001)	(0.0002)
House Value (000)	−0.006	−0.006	−0.00000**	−0.00000***	−0.00001***
	(0.007)	(0.007)	(0.00000)	(0.00000)	(0.00000)
English 2nd Language (%)	−7.929***	−7.966***	0.00004	−0.0002	−0.005***
	(2.716)	(2.719)	(0.0001)	(0.0002)	(0.0003)
Tertiary Degree (%)	2.797	3.134	−0.001	−0.001	0.004*
	(17.135)	(17.155)	(0.0005)	(0.001)	(0.002)
Polling Place FE	✓	✓	✓	✓	✓
Observations (Polling Place × Year)	23,096	23,096	23,096	23,096	23,096
R^2	0.112	0.112	0.342	0.105	0.756

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Time period fixed effects use 2007 as the reference year. R^2 for FE models is the unadjusted 'within' R^2 *p<0.1; **p<0.05; ***p<0.01

Table B.7: Placebo Test - Panel B - Propensity Score Matched

	Dependent variable:				
	Total House Votes	Total Senate Votes	Senate Informal %	Senate Donkey %	Senate Other %
	(1)	(2)	(3)	(4)	(5)
Margin	322.256***	318.229***	−0.012***	−0.028***	−0.119***
	(101.362)	(101.376)	(0.004)	(0.009)	(0.017)
Voters	244.436*	242.289*	0.034***	0.119***	−0.064***
	(133.106)	(133.255)	(0.005)	(0.011)	(0.019)
ln(N Options)	−0.542	−1.759	−0.001*	−0.008***	−0.022***
	(17.633)	(17.641)	(0.001)	(0.002)	(0.003)
Change in Margin	167.477	167.086	−0.006	−0.008	−0.030
	(152.190)	(151.332)	(0.009)	(0.008)	(0.024)
Change in ln(Voters)	317.690	306.540	0.009	0.088***	0.100***
	(253.489)	(253.373)	(0.011)	(0.014)	(0.037)
Change in ln(N Options)	2.860	1.888	−0.002	−0.002	−0.005
	(31.565)	(31.563)	(0.002)	(0.002)	(0.006)
Changed Division	13.959	14.219	0.0001	−0.001	−0.014***
	(13.263)	(13.263)	(0.001)	(0.001)	(0.002)
2010	−117.530***	−117.900***	0.015***	0.002*	0.025***
	(14.171)	(14.196)	(0.001)	(0.001)	(0.002)
2013	−287.311***	−287.029***	0.006***	0.004**	0.144***
	(28.179)	(28.184)	(0.001)	(0.002)	(0.004)
2016	−299.232***	−298.662***	0.016***	−0.007**	0.190***
	(37.803)	(37.837)	(0.001)	(0.003)	(0.005)
Median Age	1.385	1.419	0.0001	−0.002***	0.004***
	(4.902)	(4.906)	(0.0002)	(0.0004)	(0.001)
Mean Income (000)	5.997***	5.960***	−0.0001**	−0.001***	−0.001***
	(1.293)	(1.294)	(0.00005)	(0.0001)	(0.0002)
Unemployment (%)	−11.554	−11.383	0.0005	−0.009***	−0.004
	(55.866)	(55.984)	(0.002)	(0.003)	(0.009)
Population Density	0.004	0.005	−0.00000	−0.00000**	−0.00001**
	(0.044)	(0.044)	(0.00000)	(0.00000)	(0.00000)
Population Growth (%)	9.020**	8.968**	0.0002**	0.001***	0.002***
	(4.512)	(4.524)	(0.0001)	(0.0003)	(0.0005)
Population Decline (%)	−3.650	−3.583	0.0001	0.0004**	−0.001***
	(3.486)	(3.497)	(0.0001)	(0.0002)	(0.0004)
House Value (000)	−0.012	−0.011	0.00000	−0.000	−0.00001***
	(0.021)	(0.021)	(0.00000)	(0.00000)	(0.00000)
English 2nd Language (%)	−10.545**	−10.551**	0.0001	−0.0002	−0.005***
	(4.440)	(4.445)	(0.0001)	(0.0003)	(0.0005)
Tertiary Degree (%)	−19.832	−18.848	−0.001	0.001	0.010***
	(23.613)	(23.695)	(0.001)	(0.001)	(0.003)
Polling Place FE	✓	✓	✓	✓	✓
Observations (Polling Place × Year)	11,677	11,677	11,677	11,677	11,677
R^2	0.114	0.113	0.415	0.088	0.776

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Time period fixed effects use 2007 as the reference year. R^2 for FE models is the unadjusted 'within' R^2 *p<0.1; **p<0.05; ***p<0.01

Table B.8: Quartiles of Percentage with Tertiary Degree - Panel A - Standard

	Dependent variable: Informal %			
	Quartile 1 (lowest)	Quartile 2	Quartile 3	Quartile 4 (highest)
Margin	-3.805^{***}	-3.173^{***}	-5.344^{***}	-2.557^{***}
	(0.789)	(0.760)	(0.780)	(0.583)
ln(Voters)	3.573^{***}	-0.470	0.135	-1.378^{*}
	(0.769)	(0.695)	(0.630)	(0.824)
ln(N Options)	2.329^{***}	2.289^{***}	1.863^{***}	1.758^{***}
	(0.137)	(0.121)	(0.101)	(0.105)
Change in Margin	-3.550^{***}	-3.521^{*}	-4.094^{*}	4.040^{**}
	(1.366)	(2.049)	(2.322)	(1.683)
Change in ln(Voters)	-1.661	-2.326	0.755	-1.996
	(2.794)	(2.140)	(2.085)	(1.999)
Change in ln(N Options)	2.605^{***}	1.936^{***}	2.021^{***}	3.198^{***}
	(0.371)	(0.482)	(0.414)	(0.377)
Changed Division	-0.305^{**}	-0.457^{***}	-0.180^{*}	-0.052
	(0.133)	(0.141)	(0.107)	(0.118)
2010	2.236^{***}	2.089^{***}	2.211^{***}	1.700^{***}
	(0.095)	(0.082)	(0.077)	(0.070)
2013	1.786^{***}	1.788^{***}	2.203^{***}	1.993^{***}
	(0.170)	(0.158)	(0.170)	(0.139)
2016	1.476^{***}	1.904^{***}	1.749^{***}	1.481^{***}
	(0.231)	(0.214)	(0.217)	(0.178)
Median Age	-0.065^{*}	0.010	0.007	-0.017
	(0.034)	(0.030)	(0.028)	(0.027)
Mean Income (000)	-0.004	-0.001	-0.016^{*}	-0.013^{**}
	(0.010)	(0.009)	(0.010)	(0.005)
Unemployment (%)	-0.622^{*}	0.195	-0.662	0.852^{*}
	(0.369)	(0.248)	(0.496)	(0.458)
Population Density	-0.001	0.002^{***}	0.001^{**}	-0.00000
	(0.001)	(0.001)	(0.0003)	(0.0001)
Population Growth (%)	0.017	0.024	-0.010	-0.009
	(0.018)	(0.030)	(0.016)	(0.025)
Population Decline (%)	0.019	0.060^{**}	0.043^{***}	-0.008
	(0.030)	(0.025)	(0.016)	(0.013)
House Value (000)	0.0004	0.00004	-0.0001	0.00002
	(0.0004)	(0.0003)	(0.0001)	(0.00003)
English 2nd Language (%)	-0.017	-0.050	-0.082^{***}	-0.058^{***}
	(0.040)	(0.036)	(0.028)	(0.016)
Tertiary Degree (%)	0.308	-0.106	-0.162	0.245^{**}
	(0.430)	(0.225)	(0.154)	(0.121)
Polling Place FE	✓	✓	✓	
Mean of Informal %	5.66	5.55	5.46	4.44
Observations (Polling Place × Year)	5,894	5,660	5,711	5,767
R^2	0.327	0.375	0.428	0.369

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Quartile 1 represents areas with the lowest percentage of people with tertiary degrees while Quartile 4 represents areas with the highest percentage of people with tertiary degrees. Time period fixed effects use 2007 as the reference year. R^2 for FE models is the unadjusted 'within' R^2 *p<0.1; **p<0.05; ***p<0.01

Table B.9: Quartiles of Percentage with Tertiary Degree - Panel B - Propensity Score Matched

	Dependent variable: Informal %			
	Quartile 1 (lowest)	Quartile 2	Quartile 3	Quartile 4 (highest)
Margin	-3.078^{***}	-4.839^{***}	-7.115^{***}	-7.317^{***}
	(1.141)	(1.291)	(1.365)	(1.165)
ln(Voters)	4.960^{***}	3.633^{***}	1.757	-0.030
	(1.329)	(1.184)	(1.139)	(1.232)
ln(N Options)	2.408^{***}	2.328^{***}	2.128^{***}	1.703^{***}
	(0.217)	(0.228)	(0.177)	(0.173)
Change in Margin	-4.519^{***}	-5.767^{**}	-1.894	-1.235
	(1.733)	(2.415)	(2.330)	(2.554)
Change in ln(Voters)	-4.437	0.058	-0.187	0.496
	(3.615)	(2.487)	(2.569)	(2.939)
Change in ln(N Options)	3.003^{***}	2.760^{***}	1.614^{***}	2.534^{***}
	(0.553)	(0.602)	(0.519)	(0.463)
Changed Division	-0.441^{**}	-0.492^{**}	-0.375^{**}	-0.338^{**}
	(0.203)	(0.200)	(0.155)	(0.139)
2010	2.413^{***}	2.055^{***}	2.571^{***}	1.965^{***}
	(0.163)	(0.139)	(0.155)	(0.130)
2013	1.755^{***}	1.447^{***}	2.742^{***}	2.212^{***}
	(0.281)	(0.269)	(0.330)	(0.254)
2016	1.548^{***}	1.204^{***}	2.424^{***}	1.292^{***}
	(0.387)	(0.362)	(0.409)	(0.333)
Median Age	-0.076	0.009	0.010	0.120^{**}
	(0.052)	(0.052)	(0.049)	(0.057)
Mean Income (000)	-0.010	0.003	-0.042^{**}	-0.008
	(0.015)	(0.013)	(0.021)	(0.013)
Unemployment (%)	-1.953^{***}	-0.316	-0.039	1.074
	(0.502)	(0.808)	(0.632)	(0.758)
Population Density	0.001	0.001	0.001^{**}	-0.00004
	(0.001)	(0.001)	(0.0004)	(0.0003)
Population Growth (%)	0.075	0.022	0.014	0.026
	(0.046)	(0.022)	(0.032)	(0.031)
Population Decline (%)	0.136^{**}	0.020	0.071^{***}	0.014
	(0.061)	(0.021)	(0.025)	(0.018)
House Value (000)	0.001	-0.0002	-0.001^{**}	0.0002
	(0.001)	(0.001)	(0.0005)	(0.0001)
English 2nd Language (%)	-0.131^{*}	0.016	-0.147^{***}	-0.003
	(0.077)	(0.037)	(0.039)	(0.029)
Tertiary Degree (%)	-0.520	-0.926^{**}	0.190	0.317^{*}
	(0.529)	(0.452)	(0.498)	(0.180)
Polling Place FE	✓	✓	✓	
Observations	3,036	2,793	2,886	2,880
R^2	0.356	0.367	0.453	0.441

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Quartile 1 represents areas with the lowest percentage of people with tertiary degrees while Quartile 4 represents areas with the highest percentage of people with tertiary degrees. Time period fixed effects use 2007 as the reference year. R^2 for FE models is the unadjusted 'within' R^2 *p<0.1; **p<0.05; ***p<0.01

Table B.10: Main Results - Including Tenure and Progressive Share

	Dependent variable: Informal %					
	Model specifications					
	OLS	OLS w cov	FE	DID Std	DID PSM	DID DL
	(1)	(2)	(3)	(4)	(5)	(6)
Margin	0.792^{***}	-0.030	-3.547^{***}	-3.422^{***}	-5.329^{***}	-5.565^{***}
	(0.294)	(0.285)	(0.361)	(0.368)	(0.614)	(0.638)
ln(Voters)	1.859^{***}	1.400^{***}	0.863^{**}	0.979^{***}	3.259^{***}	0.527
	(0.147)	(0.157)	(0.352)	(0.361)	(0.603)	(0.600)
ln(N Options)	0.790^{***}	0.865^{***}	2.155^{***}	2.054^{***}	2.170^{***}	1.726^{***}
	(0.051)	(0.054)	(0.057)	(0.057)	(0.097)	(0.112)
ln(Tenure)	-0.101^{***}	-0.075^{***}	-0.060^{***}			
	(0.021)	(0.021)	(0.021)			
Progressive Vote Share (%)	0.552^{***}	0.162	1.245^{***}			
	(0.114)	(0.115)	(0.123)			
Change in Margin				-2.242^{**}	-3.753^{***}	-3.195^{***}
				(0.907)	(1.097)	(0.936)
Change in ln(Voters)				-0.962	-0.508	-0.276
				(1.114)	(1.375)	(1.169)
Change in ln(N Options)				2.397^{***}	2.501^{***}	2.200^{***}
				(0.206)	(0.260)	(0.209)
Change in ln(Tenure)				0.006	0.055	-0.037
				(0.066)	(0.085)	(0.066)
Change in Progressive Vote Share				0.188	0.991	0.724
				(0.856)	(1.143)	(0.892)
Changed Division				-0.322^{***}	-0.538^{***}	-0.294^{***}
				(0.100)	(0.138)	(0.102)
2010		1.579^{***}	2.005^{***}	2.082^{***}	2.238^{***}	2.343^{***}
		(0.031)	(0.039)	(0.039)	(0.071)	(0.073)
2013		1.602^{***}	2.095^{***}	2.015^{***}	1.945^{***}	2.853^{***}
		(0.041)	(0.073)	(0.073)	(0.134)	(0.135)
2016		0.761^{***}	1.757^{***}	1.733^{***}	1.508^{***}	2.158^{***}
		(0.052)	(0.099)	(0.099)	(0.178)	(0.178)
Median Age	-0.021^{***}	-0.030^{***}	-0.003	-0.008	-0.007	0.108^{***}
	(0.004)	(0.005)	(0.015)	(0.015)	(0.026)	(0.027)
Mean Income (000)	0.036^{***}	0.021^{***}	-0.015^{***}	-0.016^{***}	-0.011	-0.042^{***}
	(0.002)	(0.002)	(0.004)	(0.004)	(0.007)	(0.007)
Unemployment (%)	0.137^{***}	0.124^{***}	-0.162	-0.135	-0.751^{**}	-0.103
	(0.012)	(0.012)	(0.187)	(0.189)	(0.316)	(0.424)
Population Density	0.0002^{***}	0.0002^{***}	0.00002	0.00003	0.0002	0.0002
	(0.00003)	(0.00003)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Population Growth (%)	-0.042^{***}	-0.023^{**}	0.007	0.002	0.026^{*}	0.034^{**}
	(0.009)	(0.009)	(0.011)	(0.011)	(0.015)	(0.017)
Population Decline (%)	-0.004	0.014^{**}	-0.005	-0.004	0.023^{*}	0.006
	(0.006)	(0.007)	(0.008)	(0.007)	(0.013)	(0.012)
House Value (000)	0.00005^{*}	0.0001^{***}	-0.00004	-0.00003	0.0001	-0.00004
	(0.00003)	(0.00003)	(0.00002)	(0.00002)	(0.0001)	(0.00003)
English 2nd Language (%)	0.072^{***}	0.071^{***}	-0.059^{***}	-0.064^{***}	-0.066^{***}	-0.059^{***}
	(0.003)	(0.003)	(0.013)	(0.013)	(0.021)	(0.018)
Tertiary Degree (%)	-0.143^{***}	-0.129^{***}	0.037	0.027	0.053	0.090
	(0.003)	(0.003)	(0.073)	(0.075)	(0.113)	(0.101)
Constant	-18.309^{***}	-13.008^{***}				
	(1.629)	(1.772)				
Polling Place FE			✓	✓	✓	✓
Clusters (Polling Place)	5,930	5,930	5,930	5,930	4,195	1,955
Observations (Polling Place × Year)	23,096	23,096	23,096	23,083	11,677	7,470
Treated Observations	NA	NA	NA	1,415	1,063	1,415
Control Observations	NA	NA	NA	21,681	10,614	6,068
R^2	0.373	0.433	0.360	0.356	0.378	0.414

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Share of progressive vote is defined as votes for Labor and Greens and the calculation excludes all votes for other minor parties. Change in progressive vote share is the absolute value of the exogenous change in votes for Labor and Green candidates due to a polling place changing electoral divisions. R^2 for FE models is the unadjusted 'within' R^2 $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table B.11: Main Results - Margin Defined on First Preferences

	Dependent variable: Informal %					
	Model specifications					
	OLS	OLS w cov	FE	DID Std	DID PSM	DID DL
	(1)	(2)	(3)	(4)	(5)	(6)
Margin	0.898***	0.597***	0.238	0.237	−1.073***	−1.497***
	(0.150)	(0.125)	(0.163)	(0.167)	(0.275)	(0.315)
ln(Voters)	3.512***	1.203***	0.580*	0.686*	2.589***	0.165
	(0.193)	(0.158)	(0.349)	(0.359)	(0.590)	(0.613)
ln(N Options)	0.423***	0.888***	2.175***	2.157***	2.325***	1.831***
	(0.067)	(0.053)	(0.057)	(0.057)	(0.098)	(0.117)
Change in Margin				0.275	−0.349	−0.646
				(0.414)	(0.534)	(0.432)
Change in ln(Voters)				−0.890	−1.402	−0.326
				(1.112)	(1.385)	(1.157)
Change in ln(N Options)				2.524***	2.590***	2.348***
				(0.207)	(0.267)	(0.212)
Changed Division				−0.257***	−0.420***	−0.163**
				(0.065)	(0.091)	(0.065)
2010		1.589***	2.084***	2.074***	2.288***	2.359***
		(0.029)	(0.040)	(0.040)	(0.073)	(0.074)
2013		1.589***	2.065***	2.041***	2.083***	2.943***
		(0.041)	(0.074)	(0.074)	(0.135)	(0.139)
2016		0.795***	1.868***	1.849***	1.725***	2.291***
		(0.051)	(0.098)	(0.099)	(0.177)	(0.182)
Median Age		−0.033***	−0.024	−0.024	−0.001	0.091***
		(0.005)	(0.015)	(0.015)	(0.026)	(0.027)
Mean Income (000)		0.020***	−0.019***	−0.019***	−0.017**	−0.044***
		(0.002)	(0.004)	(0.004)	(0.007)	(0.007)
Unemployment (%)		0.133***	−0.122	−0.125	−0.767**	−0.159
		(0.012)	(0.183)	(0.183)	(0.300)	(0.422)
Population Density		0.0002***	0.0001	0.0001	0.0002	0.0002*
		(0.00003)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Population Growth (%)		−0.021**	0.0004	0.001	0.028*	0.029*
		(0.009)	(0.011)	(0.011)	(0.015)	(0.016)
Population Decline (%)		0.013*	−0.003	−0.003	0.026*	0.005
		(0.006)	(0.008)	(0.008)	(0.013)	(0.013)
House Value (000)		0.0001***	−0.00003	−0.00003	0.0001	−0.00002
		(0.00003)	(0.00002)	(0.00002)	(0.0001)	(0.00002)
English 2nd Language (%)		0.071***	−0.078***	−0.080***	−0.078***	−0.071***
		(0.003)	(0.013)	(0.013)	(0.021)	(0.018)
Tertiary Degree (%)		−0.127***	0.043	0.035	0.056	0.100
		(0.003)	(0.076)	(0.076)	(0.111)	(0.099)
Constant	−33.425***	−36.041***	−10.923***			
	(2.165)	(1.789)				
Polling Place FE			✓	✓	✓	✓
Clusters (Polling Place)	5,930	5,930	5,930	5,930	4,195	1,955
Observations (Polling Place × Year)	23,101	23,101	23,101	23,101	11,677	7,488
Treated Observations	NA	NA	NA	1,420	1,063	1,420
Control Observations	NA	NA	NA	21,681	10,614	6,068
R^2	0.030	0.433	0.349	0.350	0.369	0.404

Note: Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at the Polling Place level. Column 1 shows the results of a simple linear regression; Column 2 introduces a range of socioeconomic covariates; Column 3 introduces fixed effects for Polling Place. Columns 4-6 shows the results of DID v1. Column 4 presents the main output, which uses voting in the House with treated Polling Places being those that moved between electoral divisions and control Polling Places being those that did not move. Column 5 shows the same model but after propensity score matching to make the observable characteristics of treated and control groups similar has been applied; Column 6 shows results where the sample is limited to Polling Places within 2.5 kilometers of treated Polling Places. R^2 for FE models is the unadjusted 'within' R^2. *p<0.1; **p<0.05; ***p<0.01

C

Representative summary table

This appendix sets out the full listing of results of the SSM national survey by electorate including information on representatives, their position and vote.

Division	Yes Percentage	Representative	Party	Position	Vote
Blaxland	26.1	Jason Clare	ALP	Supporter	For
Watson	30.4	Tony Burke	ALP	Supporter	For
McMahon	35.1	Chris Bowen	ALP	Supporter	For
Fowler	36.3	Chris Hayes	ALP	Opposed	For
Werriwa	36.3	Anne Stanley	ALP	Supporter	For
Parramatta	38.4	Julie Owens	ALP	Supporter	For
Chifley	41.3	Ed Husic	ALP	Supporter	For
Calwell	43.2	Maria Vamvakinou	ALP	Unknown	For
Barton	43.6	Linda Burney	ALP	Supporter	For
Maranoa	43.9	David Littleproud	LNP	Opposed	Against
Banks	44.9	David Coleman	LNP	Supporter	For
Greenway	46.4	Michelle Rowland	ALP	Supporter	For
Kennedy	46.7	Bob Katter	KAP	Opposed	Against
Bruce	46.9	Julian Hill	ALP	Supporter	For
Mitchell	49.1	Alex Hawke	LNP	Opposed	Abstain
Groom	49.2	John McVeigh	LNP	Opposed	For
Bennelong	49.8	John Alexander	LNP	Supporter	
Holt	50.7	Anthony Byrne	ALP	Unknown	Abstain
Hinkler	50.7	Keith Pitt	LNP	Opposed	Against
Flynn	51.5	Ken O'Dowd	LNP	Opposed	For
Macarthur	52.1	Mike Freelander	ALP	Supporter	For
Barker	52.3	Tony Pasin	LNP	Unknown	For
New England	52.5	Barnaby Joyce	NAT	Opposed	Abstain
Parkes	52.7	Mark Coulton	NAT	Unknown	For
Reid	52.7	Craig Laundy	LNP	Unknown	For
Gorton	53.3	Brendan O'Connor	ALP	Supporter	Abstain
Grey	53.3	Rowan Ramsey	LNP	Unknown	For
Scullin	53.4	Andrew Giles	ALP	Supporter	For
Braddon	54	Justine Keay	ALP	Supporter	For
Capricornia	54.1	Michelle Landry	LNP	Unknown	For
Mallee	54.3	Andrew Broad	NAT	Opposed	For
Lingiari	54.5	Warren Snowdon	ALP	Supporter	For
Berowra	54.6	Julian Leeser	LNP	Opposed	For
Riverina	54.6	Michael McCormack	NAT	Opposed	For
Rankin	54.6	Jim Chalmers	ALP	Supporter	For

Division	Yes Percentage	Representative	Party	Position	Vote
Cook	55	Scott Morrison	LNP	Opposed	Abstain
Dawson	55.1	George Christensen	LNP	Opposed	Against
Farrer	55.2	Sussan Ley	LNP	Supporter	For
Lyne	55.3	David Gillespie	NAT	Opposed	Abstain
Wide Bay	55.6	Llew O'Brien	LNP	Opposed	For
Lindsay	56.2	Emma Husar	ALP	Supporter	For
O'Connor	56.2	Rick Wilson	LNP	Opposed	Abstain
Lalor	56.8	Joanne Ryan	ALP	Supporter	For
Wright	56.8	Scott Buchholz	LNP	Opposed	For
Menzies	57	Kevin Andrews	LNP	Opposed	Abstain
Burt	57	Matt Keogh	ALP	Supporter	For
Murray	57.6	Damian Drum	NAT	Supporter	For
Hughes	58.4	Craig Kelly	LNP	Opposed	For
Hume	58.6	Angus Taylor	LNP	Unknown	For
Lyons	58.7	Brian Mitchell	ALP	Supporter	For
Cowan	58.8	Anne Aly	ALP	Supporter	For
Durack	59.2	Melissa Price	NAT	Supporter	For
Hotham	59.6	Clare O'Neil	ALP	Supporter	For
Page	59.7	Kevin Hogan	NAT	Supporter	For
Maribyrnong	59.9	Bill Shorten	ALP	Supporter	For
Cowper	60	Luke Hartsuyker	NAT	Opposed	For
Blair	60	Shayne Neumann	ALP	Supporter	For
Calare	60.2	Andrew Gee	NAT	Unknown	For
Gippsland	60.2	Darren Chester	NAT	Supporter	For
Canning	60.2	Andrew Hastie	LNP	Opposed	Abstain
Oxley	60.3	Milton Dick	ALP	Supporter	For
Longman	60.4	Susan Lamb	ALP	Supporter	For
Makin	60.4	Tony Zappia	ALP	Unknown	For
Forde	60.5	Bert Van Manen	LNP	Opposed	Abstain
Bradfield	60.6	Paul Fletcher	LNP	Unknown	For
Moreton	60.9	Graham Perrett	ALP	Supporter	For
Wannon	61	Dan Tehan	LNP	Opposed	For
Wakefield	61	Nick Champion	ALP	Supporter	For
Stirling	61.1	Michael Keenan	LNP	Opposed	For
Port Adelaide	61.3	Mark Butler	ALP	Supporter	For
Chisholm	61.6	Julia Banks	LNP	Supporter	For
Petrie	61.6	Luke Howarth	LNP	Opposed	Abstain
Sturt	61.6	Christopher Pyne	LNP	Supporter	For
Tangney	61.6	Ben Morton	LNP	Unknown	For
Bass	61.7	Ross Hart	ALP	Supporter	For
Fadden	61.8	Stuart Robert	LNP	Opposed	Abstain
Gilmore	62	Ann Sudmalis	LNP	Unknown	For
Aston	62	Alan Tudge	LNP	Opposed	For
Bonner	62	Ross Vasta	LNP	Opposed	For
Bowman	62.1	Andrew Laming	LNP	Unknown	For

Division	Yes Percentage	Representative	Party	Position	Vote
Whitlam	62.3	Stephen Jones	ALP	Supporter	For
Hasluck	62.4	Ken Wyatt	LNP	Unknown	For
McMillan	62.7	Russell Broadbent	LNP	Unknown	Against
Fisher	62.8	Andrew Wallace	LNP	Supporter	For
Herbert	62.8	Cathy O'Toole	ALP	Supporter	For
Indi	63.1	Cathy McGowan	Independent	Supporter	For
Hindmarsh	63.3	Steve Georganas	ALP	Supporter	For
Leichhardt	63.4	Warren Entsch	LNP	Supporter	For
Moncrieff	63.8	Steven Ciobo	LNP	Unknown	For
Forrest	63.8	Nola Marino	LNP	Opposed	For
Macquarie	63.9	Susan Templeman	ALP	Supporter	For
Pearce	63.9	Christian Porter	LNP	Unknown	For
Kingsford Smith	64.1	Matt Thistlethwaite	ALP	Supporter	For
Fairfax	64.3	Ted O'Brien	LNP	Unknown	For
Hunter	64.4	Joel Fitzgibbon	ALP	Supporter	For
Mayo	64.7	Rebekha Sharkie	NXT	Supporter	For
Swan	64.7	Steve Irons	LNP	Unknown	For
Eden-Monaro	64.9	Mike Kelly	ALP	Supporter	For
Dickson	65.2	Peter Dutton	LNP	Unknown	For
Isaacs	65.3	Mark Dreyfus	ALP	Supporter	For
Solomon	65.3	Luke Gosling	ALP	Supporter	For
McEwen	65.4	Rob Mitchell	ALP	Supporter	For
Paterson	65.5	Meryl Swanson	ALP	Supporter	For
McPherson	65.5	Karen Andrews	LNP	Unknown	For
Cunningham	65.7	Sharon Bird	ALP	Supporter	For
Dobell	65.7	Emma McBride	ALP	Supporter	For
Robertson	65.7	Lucy Wicks	LNP	Opposed	For
Deakin	65.7	Michael Sukkar	LNP	Opposed	Abstain
Brand	67.1	Madeleine King	ALP	Supporter	For
La Trobe	67.5	Jason Wood	LNP	Supporter	For
Shortland	67.7	Pat Conroy	ALP	Supporter	For
Corio	67.7	Richard Marles	ALP	Supporter	For
Lilley	67.7	Wayne Swan	ALP	Supporter	Abstain
Richmond	67.9	Justine Elliot	ALP	Supporter	For
Mackellar	68	Jason Falinski	LNP	Supporter	For
Moore	68	Ian Goodenough	LNP	Opposed	For
Casey	68.1	Tony Smith	LNP	Opposed	
Gellibrand	68.1	Tim Watts	ALP	Supporter	For
Kingston	68.1	Amanda Rishworth	ALP	Supporter	For
Boothby	68.5	Nicolle Flint	LNP	Unknown	For
Bendigo	68.7	Lisa Chesters	ALP	Supporter	For
Franklin	68.8	Julie Collins	ALP	Supporter	For
Flinders	70	Greg Hunt	LNP	Supporter	For

Division	Yes Percentage	Representative	Party	Position	Vote
Wills	70	Peter Khalil	ALP	Supporter	For
Adelaide	70.1	Kate Ellis	ALP	Supporter	For
Fremantle	70.1	Josh Wilson	ALP	Supporter	For
Ballarat	70.5	Catherine King	ALP	Supporter	For
Batman	71.2	David Feeney	ALP	Supporter	For
Perth	71.5	Tim Hammond	ALP	Supporter	For
Corangamite	71.6	Sarah Henderson	LNP	Supporter	For
North Sydney	71.8	Trent Zimmerman	LNP	Supporter	For
Dunkley	72	Chris Crewther	LNP	Supporter	For
Curtin	72.2	Julie Bishop	LNP	Supporter	For
Ryan	72.7	Jane Prentice	LNP	Unknown	For
Jagajaga	73.5	Jenny Macklin	ALP	Supporter	For
Kooyong	73.7	Josh Frydenberg	LNP	Supporter	For
Denison	73.8	Andrew Wilkie	Independent	Supporter	For
Fenner	74	Andrew Leigh	ALP	Supporter	For
Canberra	74.1	Gai Brodtmann	ALP	Supporter	For
Newcastle	74.8	Sharon Claydon	ALP	Supporter	For
Warringah	75	Tony Abbott	LNP	Opposed	Abstain
Goldstein	76.3	Tim Wilson	LNP	Supporter	For
Griffith	76.6	Terri Butler	ALP	Supporter	For
Higgins	78.3	Kelly O'Dwyer	LNP	Supporter	For
Brisbane	79.5	Trevor Evans	LNP	Supporter	For
Grayndler	79.9	Anthony Albanese	ALP	Supporter	For
Wentworth	80.8	Malcolm Turnbull	LNP	Supporter	For
Melbourne Ports	82	Michael Danby	ALP	Supporter	For
Sydney	83.7	Tanya Plibersek	ALP	Supporter	For
Melbourne	83.7	Adam Bandt	AG	Supporter	For

D

SSM bigrams

This appendix sets out the full list of SSM related bigrams identified through the process described in Section 3.4.

"marriag equal"	"freedom speech"	"religi conscienti"	"free vote"
"sex marriag"	"view marriag"	"vote favour"	"hold express"
"marriag amend"	"tradit marriag"	"relev belief"	"lgbtiq australian"
"freedom bill"	"equal law"	"refus solemnis"	"marriag marriag"
"amend definit"	"chang marriag"	"marriag woman"	"public author"
"definit religi"	"gai lesbian"	"insert authoris"	"support sex"
"support marriag"	"marriag belief"	"philip ruddock"	"bill marriag"
"definit marriag"	"lgbti commun"	"remov discrimin"	"entiti hold"
"postal survei"	"sex coupl"	"freedom protect"	"minist religion"
"marriag celebr"	"relev marriag"	"marriag bill"	"speech freedom"
"lgbtiq commun"	"vote marriag"	"coupl marri"	"union woman"
"solemnis marriag"	"marriag law"	"cent vote"	"belief marriag"

"chang definit"
"chaplain insert"
"tradit view"
"charit statu"
"respect view"
"religi bodi"
"sex relationship"
"australian marriag"
"genuin religi"
"protect bill"
"amend marriag"
"australian vote"
"belief relev"
"debat marriag"
"engag conduct"
"enter life"
"marriag union"
"equal bill"
"form discrimin"
"lesbian australian"
"penni wong"
"peopl sex"
"religi marriag"
"speak marriag"
"bill protect"
"equal realiti"
"exclus voluntarili"
"favour marriag"
"freedom freedom"
"marriag ceremoni"
"sexual orient"
"tradit definit"
"voluntarili enter"
"institut marriag"
"marriag sex"
"parent right"
"substitut tradit"
"person entiti"
"protect freedom"
"legisl marriag"
"modern slaveri"
"omit religi"
"religi institut"
"religi substitut"
"woman exclus"
"equal right"
"gai peopl"
"statement opinion"
"survei result"
"tradit schedul"
"vote postal"
"vote support"
"issu sex"
"legisl sex"
"marriag australian"
"person love"
"belief person"
"conscienc freedom"
"doctrin tenet"
"genuin believ"
"lgbti australian"
"relat marriag"
"religi convict"
"tenet belief"
"senat smith"
"religi belief"
"authoris celebr"
"civil marriag"
"equal campaign"
"issu marriag"
"issu religi"
"legalis sex"
"love equal"
"marri person"
"postal vote"
"religi chariti"
"religi school"
"religion freedom"
"rodnei croom"
"vote cent"
"religi freedom"
"belief religion"
"conscienc religion"
"equal love"
"equal vote"
"peopl marri"
"postal plebiscit"
"refus servic"
"senat penni"
"smith bill"
"subsect chaplain"
"achiev marriag"
"bill right"
"choos marri"
"conscienti object"
"deepli held"
"equal survei"
"equal time"
"free speech"
"louis pratt"
"marriag legisl"
"marriag recognis"
"survei process"
"conscienti belief"
"religi protect"
"lgbtiq peopl"
"celebr religi"
"equal debat"
"express relev"
"freedom hold"
"hold tradit"
"ill vote"
"marriag chang"
"nation result"
"offenc contravent"
"religi faith"
"religi view"
"result cent"
"ruddock review"
"support tradit"
"view express"
"law chang"
"authoris subsect"
"celebr perform"
"chaplain authoris"
"consent adult"
"debat parliament"
"decriminalis homosexu"
"elig australian"
"equal equal"
"favour sex"
"gender sexual"
"item substitut"
"marriag includ"
"marriag protect"
"marriag religi"
"pass marriag"
"religi ceremoni"
"religion refus"
"support religi"
"vote australian"
"vote parliament"
"vote survei"
"cathol church"
"belief mention"
"brother sister"
"defin marriag"
"discrimin sex"
"ensur religi"
"favour chang"
"freedom religi"
"held belief"
"law marriag"
"marriag peopl"
"marriag time"
"mention paragraph"
"oppos marriag"
"peopl marriag"
"question marriag"
"refus omiss"
"regist marriag"
"religi suscept"
"repres democraci"
"result announc"
"senat louis"
"sex attract"
"solemnis sex"
"support freedom"
"survei vote"
"time come"
"vote im"
"celebr refus"
"elig voter"
"ensur protect"
"equal parliament"
"freedom conscienc"

“freedom peopl”

“hold belief”

“legisl chang”

“lgbti peopl”

“peopl equal”

“posit marriag”

“question sex”

“sex marri”

“teach marriag”

“protect religi”

“civil celebr”

“express view”

“amend pass”

“anti discrimin”

“authoris section”

“avoid injuri”

“belief amend”

“belief entiti”

“cent respond”

“chang sex”

“commit love”

“conduct marriag”

“conform doctrin”

“consist relev”

“dual citizen”

“enrol vote”

“express act”

“express associ”

“faith religi”

“freedom australian”

“freedom parent”

“fundament freedom”

“gender ident”

“held view”

“heterosexu coupl”

“hon philip”

“im vote”

“injuri religi”

“loss damag”

“love peopl”

“love relationship”

“marri coupl”

“marriag debat”

“marriag person”

“marriag survei”

“peopl hold”

“perform sex”

“person person”

“proud vote”

“relationship recognis”

“religi object”

“religion parent”

“respect australian”

“right equal”

“sex wed”

“strong religi”

“support equal”

“suscept adher”

“univers declar”

“vote chang”

“vote overwhelmingli”

“voter vote”

E

LASSO coefficient values

This appendix sets out the full list of bigrams and coefficients resulting for the LASSO model used in Chapter 2 ordered from lowest coefficient to highest coefficient.

Table E.1: LASSO Coefficient values

express act	-75.621
freedom parent	-47.403
express associ	-27.584
tradit definit	-18.058
conscienc freedom	-16.827
religion parent	-15.532
tradit marriag	-12.758
relev belief	-10.381
question sex	-5.881
definit marriag	-5.328
religi protect	-4.166
marriag debat	-3.793
hon philip	-3.037
perform sex	-3.004
religi ceremoni	-2.873
marriag woman	-2.706
belief amend	-2.373
marriag legisl	-2.146
belief person	-2.078
religi view	-1.605
protect religi	-1.437
result announc	-1.159
marriag bill	-0.994
marriag peopl	-0.985
philip ruddock	-0.975
support freedom	-0.934
solemnis sex	-0.920
religi belief	-0.880
union woman	-0.820
loss damag	-0.767

Table E.2: LASSO Coefficient values (continued)

engag conduct	-0.741
sex marriag	-0.666
vote survei	-0.614
amend definit	-0.527
choos marri	-0.489
civil marriag	-0.482
teach marriag	-0.467
relationship recognis	-0.294
free speech	-0.236
issu sex	-0.225
commit love	-0.186
offenc contravent	-0.142
item substitut	-0.044
refus omiss	-0.014
respect australian	-0.008
cent vote	-0.0003
achiev marriag	0.001
vote parliament	0.071
modern slaveri	0.102
lgbtiq commun	0.115
person love	0.166
result cent	0.241
brother sister	0.260
australian vote	0.375
sexual orient	0.406
debat parliament	0.425
remov discrimin	0.632
defin marriag	1.207
(Intercept)	1.241
postal survei	1.437
lgbti australian	1.547
conform doctrin	1.683
marriag equal	3.173
support marriag	4.033
religi marriag	5.079

F

Municipalities remaining in final civility data set

Following preparation of the data for sentiment analysis, the list of cities remaining in the data used in Chapter 3 are:

- Albuquerque, New Mexico
- Austin, Texas
- Boston, Massachusetts
- Buffalo, New York
- Charlotte, North Carolina
- Chicago, Illinois
- Cincinnati, Ohio
- Cleveland, Ohio
- Colorado Springs, Colorado
- Denver, Colorado

- Detroit, Michigan
- Fort Wayne, Indiana
- Honolulu, Hawaii
- Houston, Texas
- Jacksonville, Florida
- Jersey City, New Jersey
- Lexington, Kentucky
- Lubbock, Texas
- Madison, Wisconsin
- Miami, Florida
- Minneapolis, Minnesota
- Nashville, Tennessee
- New York, New York
- Oakland, California
- Orlando, Florida
- Philadelphia, Pennsylvania
- Phoenix, Arizona
- Pittsburgh, Pennsylvania
- Portland, Oregon
- Raleigh, North Carolina
- San Antonio, Texas
- San Diego, California
- San Francisco, California
- Seattle, Washington
- St. Paul, Minnesota
- Toledo, Ohio
- Tulsa, Oklahoma

Figure F.1: Location of Cities Included in Sentiment Analysis

Note: Map does not show Honolulu, which is included in the data

Source: Map data from Google

G

Final set of stop words

The final set of stop words included in the analysis of Chapter 3 are:

a
a's
able
about
above
according
accordingly
across
actually
after
afterwards
again
against
ain't
all
allows
almost
along
already
also
although
always
am
among
amongst
an
and
another
any
anybody
anyhow
anyone
anything
anyway
anyways
anywhere
apart
appear
are
aren't
around
as
aside
ask
asking
associated
at
away
b
be
became
because

become
becomes
becoming
been
before
beforehand
behind
being
believe
below
beside
besides
between
beyond
both
brief
but
by
c
c'mon
c's
came
can
can't
cannot
cant
cause
causes
certainly
changes
co
com
come
comes
concerning
consequently
consider
considering
contain
containing
contains
corresponding
could
couldn't
course
currently
d
definitely
described
despite
did
didn't
different
do
does
doesn't
doing
don't
done
down
downwards
during
e
each
edu
eg
eight
either
else
elsewhere
entirely
especially
et
etc
even
ever
every
everybody
everyone
everything
everywhere
ex
exactly
example
except
f
far
few
fifth
first
five
followed
following
follows
for
former
formerly
forth
four
from
further
furthermore
g
get
gets
getting
given
gives
go
goes
going
gone
got
gotten
h
had
hadn't
happens
hardly
has
hasn't
have
haven't
having
he
he's
hello
hence
her
here
here's
hereafter
hereby
herein
hereupon
hers
herself
hi
him
himself
his
hither
how
howbeit
however
i
i'd
i'll
i'm
i've
ie
if
immediate
in
inasmuch
inc
indeed
indicate
indicated
indicates
inner
insofar
instead
into
inward
is
isn't
it
it'd
it'll
it's
its
itself
j
just
k

keep
keeps
kept
know
knows
known
l
last
lately
later
latter
latterly
least
less
lest
let
let’s
likely
little
look
looking
looks
ltd
m
mainly
many
may
maybe
me
mean
meanwhile
merely
might
more
moreover
most
mostly
much
must
my
myself
n
name
namely
nd
near
nearly
necessary
need
needs
neither
never
nevertheless
new
next
nine
nobody
non
none
noone
nor
normally
not
nothing
now
nowhere
o
obviously
of
off
often
oh
ok
okay
old
on
once
one
ones
only
onto
or
other
others
otherwise
ought
our
ours
ourselves
out
outside
over
overall
own
p
particular
particularly
per
perhaps
placed
plus
possible
presumably
probably
provides
q
que
quite
qv
r
rather
rd
re
really
regarding
regardless
regards
relatively
respectively
s
said
same
saw
say
saying
says
second
secondly
see
seeing
seem
seemed
seeming
seems
seen
self
selves
sent
serious
seriously
seven
several
shall
she
should
shouldn’t
since
six
so
some
somebody
somehow
someone
something
sometime
sometimes
somewhat
somewhere
soon
specified
specify
specifying
still
sub
such
sup
sure
t
t’s
take
taken
tell
tends
th
than
thanx

that
that’s
thats
the
their
theirs
them
themselves
then
thence
there
there’s
thereafter
thereby
therefore
therein
theres
thereupon
these
they
they’d
they’ll
they’re
they’ve
think
third
this
thorough
thoroughly
those
though
three
through
throughout
thru
thus
to
together
too
took
toward
towards
tried
tries
truly
try
trying
twice
two
u
un
under
unless
until
unto
up
upon
us
use
used
uses
using
usually
uucp
v
value
various
very
via
viz
vs
w
wants
was
wasn’t
way
we
we’d
we’ll
we’re
we’ve
went
were
weren’t
what
what’s
whatever
when
whence
whenever
where
where’s
whereafter
whereas
whereby
wherein
whereupon
wherever
whether
which
while
whither
who
who’s
whoever
whole
whom
whose
why
will
with
within
without
won’t
would
wouldn’t
x
y
yet
you
you’d
you’ll
you’re
you’ve
your
yours
yourself
yourselves
z
zero
she’s
he’d
she’d
he’ll
she’ll
shan’t
mustn’t
when’s
why’s
how’s
area
areas
asked
asks
back
began
beings
cases
differ
downed
downing
downs
early
end
ended
ending
ends
face
faces
felt
find
finds
furthered
furthering
furthers
gave
generally
give
group
grouped
grouping
groups
high
higher
knew
large

largely
latest
lets
longer
longest
made
make
making
man
member
members
men
mr
mrs
needed
needing
newer
newest
number
oldest
open
opened
opening
opens
order
ordered
ordering
orders
part
parted
parts
place
places
point
pointed
pointing
points
presented
presenting
presents
put
puts
room
rooms
seconds
sees
showed
showing
shows
side
sides
smaller
smallest
state
states
thing
things
thinks
thoughts
today
turn
turned
turning
turns
wanted
ways
wells
year
years
youngest

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IN A DEMOCRACY, SOMEONE WHO fails to get elected to office can always console himself with the thought that there was something not quite fair about it.

—— *Thucydides,*
History of the Peloponnesian War