Electoral Redistricting, Incumbency Advantage, and Endogenous Candidate Selection

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Abstract

In this paper, we examine the effects of redrawing district boundaries (redistricting) on political parties' candidate selection strategies. This study is distinct from previous studies in two regards. First, we focus on a unique natural experimental setting in Australia, where a non-partisan committee determines redistricting *exogenously* to the causal mechanism constituting the process of candidate selection. Second, we develop a formal model of *endogenous* candidate selection, which assumes strategic interactions by a party that won a seat in the previous election and a party that was defeated, and examine how an exogenous shock (i.e., redistricting) affects their decisions. Our empirical results based on the Australian Lower House election data for the period of 1990-2010 are consistent with an *incumbency disadvantage* hypothesis deduced from our model; namely, a greater magnitude of redistricting significantly *increases* the probability that the winning party will replace their incumbent legislator with a fresh candidate.

Keywords: redistricting, candidate selection, incumbency advantage, natural experiment, Australia.

JEL Codes: D72, P48, C12, C72

1 Introduction

"One-vote, one-value" (i.e., all votes having an equal weight in choosing representatives) is a fundamental principle of democracy. To maintain this, when the distribution of population across electoral districts becomes substantially uneven due to population change, a country redraws the boundaries of electoral districts (redistricting) or changes the numbers of seats allocated to the geographical units (reapportionment). Economists and political scientists have investigated a wide range of topics relevant to this principle and associated redistricting and/or reapportionment decisions.[1] In this paper, we examine the under-investigated effects of redistricting on political parties' strategies for fielding their candidates for an election. Specifically, we examine how redistricting affects major parties' decisions about whether to persist with an experienced candidate who fought in the previous election (i.e., an incumbent legislator for the party that won a seat previously, or a repeat challenger for the party that was defeated) or choose a fresh candidate.

The importance of answering this question is twofold. First, it elucidates why (and when) incumbents exit from electoral competition. Existing answers to this question, which are often derived from the American context, are commonly based on an assumption that

[1]Previous scholars have investigated technical issues in allocating a discrete number of seats across districts (e.g. Balinski & Young 2001), institutional and economic determinants of malapportionment of seats (e.g. Samuels & Snyder 2001), political causes and consequences of "gerrymandering" (e.g. Abramowitz 1983, Cain 1985, Erikson 1972, Campagna & Grofman 1990, Cox & Katz 2002, Gelman & King 1994), and impacts of redistricting/reapportionment on policy outcomes (e.g. Ansolabehere, Snyder & Stewart 2000, Dye 1965, McCubbins & Schwartz 1988).

individual incumbents make a rational calculation of costs and benefits of political careers and aim to maximize their own welfare.[2] We argue, however, that the validity of this assumption is questionable, depending on political and institutional contexts. In some cases, incumbents may be obliged to give up running for re-election against their will.

Second, it helps us understand what affects the composition of experienced hands and fresh talents in a legislature. A legislature full of long-serving representatives may not be socially optimal, as it implies a high entry barrier for new politicians who may better represent new policy needs of citizens in a rapidly changing society. On the other hand, a legislature full of newcomers is not socially optimal either, because legislators' ability as policy makers presumably develops commensurate with time spent in office. Despite the normative importance, surprisingly little has been written about this composition. Although searching for the optimal composition is beyond the scope of this paper, we intend to present an institutional source of this composition.

To answer the question stated at the beginning, we focus on the Australian case of redistricting and candidate selection, which provides important methodological and theoretical advantages. That is, Australia provides a unique natural experimental setting, as the redistricting process is not susceptible to political manipulation. We will discuss institutional

[2]There are a large number of studies on congressional careers in American politics (e.g. Diermeier, Keane & Merlo 2005, Groseclose & Krehbiel 1994, Hall & Houweling 1995, Kiewiet & Zeng 1993, Messner & Polborn 2004). All of these studies focusing on the American case assume that politicians *individually* respond to pecuniary and non-pecuniary incentives and make their career decisions. Also see Section 3 for other relevant literature.

backgrounds in detail in the following section. We will also show in Section 4 that the assumption of *exogenous* redistricting is empirically supported. Australia also provides us an opportunity to consider alternative theories of candidate selection, which can be captured in a game theoretical framework. Specifically, given that political parties have a strong influence on candidate selection in Australia, we will develop a model of *endogenous* candidate selection in the contexts of parties' strategic interactions and explain how redistricting (i.e., an exogenous shock) affects political parties' candidate selection strategies.

In Section 2, we first elaborate on why we focus on Australia. In Section 3, we present a simple two-party game in a single-seat competition and derive two hypotheses under the assumptions of *incumbency advantage* and *incumbency disadvantage*. In Section 4, we then use the Australian Lower House election data for the period of 1990–2010 and show that a greater magnitude of redistricting significantly *increases* the probability that the winning party will replace their incumbent legislator with a fresh candidate. This finding is consistent with the incumbency disadvantage hypothesis; namely, when redistricting occurs, a party finds it more difficult to attract both "new" and "old" voters if they nominate an incumbent rather than a fresh candidate. We interpret that the negative effect of fielding an incumbent in the post-redistricting district on the probability of winning a seat (i.e., the incumbent's difficulty in changing his/her previous commitment to bring geographically specific policy benefits which mainly attract "old" voters) outweighs the positive effect (i.e., the incumbent's vote-mobilizing ability with his/her name recognition and social networks). Finally, in Section 5, we conclude and discuss avenues for future research.

2 Redistricting and Candidate Selection in Australia

Grofman & Handley (2008) argue that redistricting is still "the most neglected topic in electoral and institutional design in terms of comparative research" (p. v). In fact, almost all the existing studies on redistricting are specific to the U.S. In a similar vein, "for only a few countries [specifically, the U.S. and the U.K.] do detailed studies of [candidate] selection practices exist..." (Gallagher 1988, p. 1). To improve our understanding of redistricting and candidate selection from comparative perspectives, we shed light on one such under-investigated democracy – Australia.[3]

2.1 Why Australia?

We focus on Australia because, as we noted briefly in Section 1, the process of redistricting in Australia, which is specified in Part IV of the *Commonwealth Electoral Act 1918*, provides a unique natural experimental setup.[4] Specifically, a redistricting proposal is prepared by an independent, nonpartisan committee headed by the Australian Electoral Commissioner, and

[3]There is only a limited number of existing studies on the malapportionment of seats and redistricting/reapportionment in Australia (Jackman 1994, Johnston & Forrest 2009, Medew 2008), and none of them examines the topic of our interest – the effect of redistricting on candidate selection.

[4]In Australia, the process of changing the total number of seats allocated to states/territories and/or redrawing electoral boundaries within each state/territory is called *redistribution*. To follow the literature, however, we use the conventional term, redistricting. Similarly, throughout this paper, we use the word *district* instead of more commonly used words in Australia, *electoral division* or *electorate*. The intra-party process of choosing a candidate for the next election is called *pre-selection* in Australia, but we simply call it here *selection*.

after certain periods for public inspection and lodgment of objections, the final determination is made by the augmented Electoral Commission.[5] In the entire process of redistricting, there is no institutional mechanism for political parties to manipulate electoral boundaries in their favor. Indeed, any political intervention in the redistricting process is a criminal offense in Australia.[6] In 1977, the then Prime Minister Malcolm Fraser dismissed the then Minister for Administrative Services, Reg Withers, "when a Royal Commission found he had acted improperly in suggesting names for two electorates to the Chief Electoral Officer" (Smith 1994, p. 121). This well-known anecdote suggests that the principle of political neutrality is upheld in Australian politics.[7]

By contrast, in the U.S., since redistricting is approved by each state legislature, the process of redistricting is often politicized, and is widely known as "gerrymandering."[8] As a result, a range of political variables, such as the outcomes of previous elections and inter-

[5]Redistricting is legally required when the entitled number of Lower House representatives for a state or territory has changed due to population change, when the distribution of electors across districts within a state or territory deviates from objective criteria, or when seven years lapsed since the last redistricting.

[6]Parties and politicians can formally object to the proposed redistricting plan, along with other citizens and organizations, as long as they follow a legally stipulated procedure. They cannot, however, wield influence, politically and covertly, based on their political status.

[7]One may argue that the lack of political influence on the process of redistricting is only in theory but not in reality. In Section 4, we conduct "balance tests" in our natural experimental design and show that pre-treatment political variables have indeed no systematic effects on the redistricting process.

[8]There are many studies on "gerrymandering" (see footnote 1). For a recent paper developing a strategic model of parties competing to redraw boundaries in the U.S. context, see Gul & Pesendorfer (2010).

party/intra-party competition, are likely to correlate with *both* the process of redistricting (the treatment variable) *and* the process of candidate selection (the outcome variable). Therefore, unless this political influence on redistricting, which is targeted at changing future electoral outcomes, is properly controlled, any study estimating the impacts of redistricting should suffer from the problem of omitted variable bias (i.e., the violation of an assumption of *ignobility* in making causal inference). This risk is expected to be minimal when using the Australian data.

Another reason we focus on Australia is that Australia provides a new way of looking at the process of candidate selection. There exist relevant studies showing that redistricting in the U.S. affects incumbent legislators' retirement decisions (e.g. Cox & Katz 2002, Gelman & King 1994, Groseclose & Krehbiel 1994, Hall & Houweling 1995, Mixon Jr & Upadhayaya 1997, Mixon Jr & Upadhayaya 1998, Yoshinaka & Murphy 2010).[9] In the context of American politics, where the degree of party control in selecting candidates is small, it is perhaps suitable to derive hypotheses under an assumption that incumbents *independently* make their decisions to retire by considering their own welfare. As noted in Section 1, this is indeed the common assumption implicitly and undoubtedly made in the theoretical and empirical studies of careers in American politics. Although this assumption can reasonably be applied to explain electoral politics in the U.S., it is not necessarily ap-

[9]The results are mixed at best. Some argue that redistricting increases future election uncertainty and thus motivates incumbents to retire, while others argue that redistricting lowers the degree of intra-party competition and thus weakens an incentive to retire. We argue that these contradictory findings are in part due to the difficulty in accounting for the political manipulation of the redistricting process in the U.S.

plicable in other institutional contexts. In Australia, where the level of party discipline is "among the strictest found in the Anglo-American democracies" (Studlar & McAllister 1996, p. 73), it seems more sensible to assume that parties make decisions about candidate selection by considering strategic interactions with competing parties. In Section 3, we attempt to capture such a candidate-selection process in Australia with a simple model involving a party that won a seat in the previous election and a party that was defeated. Such a game-theoretical model of candidate retirement/selection, to the best of our knowledge, has never been considered in the literature.[10]

2.2 The Party-Led Candidate Selection in Australia

Before introducing the model, we explain key characteristics of candidate selection in Australia. First, the process of candidate selection is decentralized to party organizations in states/territories (Miragliotta & Errington 2010); namely, the process is different not only between parties but also within the same party (i.e., between states/territories for the same party). The most common method is selection by locally organized panels (Johns 2000). Thus, compared to the counterpart in the U.S., the Australian process of candidate selection is less formalized/institutionalized and more exclusive (i.e., to a small number of party leaders at the local level). Only recently did parties start experimenting with U.S. style

[10]A less important but unique feature of our study is that it is the first to examine incentives to replace the experienced candidate for not only a party that won a seat but also for a party that was defeated in the previous election. There is no existing study focusing on the effects of redistricting on electoral behavior of the party (or candidate) that failed to win a seat in a given district.

primary elections (Miragliotta & Errington 2010).

More importantly, political parties, rather than individual candidates and their support groups, are unambiguously key players in candidate selection. The parties "can enforce discipline among their members, not the least of which is the threat of 'deselection,' the removal as the party candidate in a district" (Studlar & McAllister 1996, p. 73). Given this strong influence by parties in nominating candidates for the next election, "An incumbent's hold over a safe seat is more likely to be at risk during an internal party pre-selection than on polling day" (Miragliotta & Errington 2010). An incumbent normally cannot argue against his/her party's decision to nominate another candidate.[11] Indeed, the Australian Labor Party requires its members to sign a pledge when joining the party, and one of the requirements in the pledge is not to nominate against endorsed candidates.[12] This means that once the party decides to nominate a fresh candidate, an incumbent cannot nominate himself/herself for the next election.

When an incumbent's party decides to nominate someone else, a remaining option for him/her to seek re-election is to leave the party and compete for the seat as an independent. This is also typically a no-win strategy. In the 2010 Lower House election, Michael Johnson, the then member for Ryan from the Liberal National Party (LNP) in Queensland, was

[11]We acknowledge that this interpretation requires more systematic analysis, and thus are in the process of writing another paper based on a game-theoretical model and qualitative data.

[12]Another major party, the Liberal Party, does not stipulate such a condition when one joins the party, but there exists an implicit agreement that party members, including incumbents, cannot argue against the party's candidate selection decisions (Sawer, Abjorensen & Larkin 2009).

deselected by the party.[13] Johnson decided to stand as an independent but obtained only 8.49% of the first-preference vote, whereas a fresh candidate from the LNP, Jane Prentice, won comfortably with 57.16% of the two-candidate preferred vote share.[14]

In sum, in Australia, key players in candidate selection are political parties. They consider and analyze strategic environments in each district, including exogenously determined electoral boundaries, and nominate their candidates to achieve their objective – i.e., to win a seat. If a small group of local party leaders wishes to replace an incumbent with a fresh candidate, the incumbent cannot easily challenge the party and is compelled to retire. The next section models this political dynamic with a simple game.

3 A Model of Endogenous Candidate Selection

In this section, we propose a simple model of endogenous candidate selection, which involves two hypotheses: incumbency advantage and incumbency disadvantage hypotheses.[15] For each, we examine an equilibrium when an exogenous shock of redistricting occurs.

[13] "Abbott on defensive over 'fix' phone message," *ABC News*, July 16, 2010.

[14] We will explain the electoral system used in the Australian Lower House elections in Section 4.

[15] There is an extensive literature on incumbency advantage – incumbent legislators' relative advantage in getting votes as compared to challengers. See Gordon & Landa (2009) for a recent review. Importantly for our study, their new analysis suggests that some sources of incumbency advantage may *harm* "high-quality" incumbents.

3.1 Basic Settings

A set of basic assumptions in our model is the following. There are two players competing for a single seat under no information asymmetry. Specifically, these players are Party A, which won the seat in the previous election, and Party B, which lost in the previous election. In Australia, two major candidates in a single-seat district are almost always from the Australian Labor Party (ALP) and the coalition of Liberal Party and National Party. We will explain the electoral system and the nature of electoral competition in more detail in Section 4.

Second, each player (i.e., party) has two strategies – to field a fresh candidate, who has never contested a seat within a given district,[16] or to field an experienced candidate, who has contested previously. The experienced candidate is different for the two parties. For Party A, it is a candidate who won the seat in the previous election and, hence, an incumbent candidate at the beginning of the game.[17] For Party B, it is a candidate who lost in the previous election. Hereinafter, we denote a fresh candidate as a *fresh*, and an experienced candidate as either an *incumbent* for Party A or a *defeated* for Party B. Formally, the two

[16]A pool of fresh candidates is assumed to be the same for both Parties A and B. They may include experienced candidates who used to run for a seat in another district but changed their district for some reason. We treat them as fresh candidates in the new (i.e., transferred) district, because, although they may have experience as a legislator, they may not have sufficient name recognition or experience within the new district. There are some intriguing cases of "district switching" behavior in Australian elections, but we leave our in-depth examination of them for future research.

[17]Unless otherwise stated explicitly, in this paper, the term, incumbent, means the incumbency at the level of electoral districts. It does not mean the incumbent *government*.

strategies for Parties A and B are {*fresh*, *incumbent*} and {*fresh*, *defeated*}, respectively.

The objective of Parties A and B is to win the seat. Thus, their expected payoffs can be represented by the probability of winning the seat. If the two-party preferred vote share is expected to exceed 50%+1 of formal ballot papers, the party wins. For simplicity, the probability of Party A winning the seat is described as a combination of α (*incumbent party advantage*), β (*incumbent candidate advantage*), and γ (*defeated candidate disadvantage*), where $\alpha > 0$, $\beta > 0$, and $\gamma > 0$.[18] For example, if Party A fields an *incumbent* and Party B fields a *defeated*, the probability of Party A winning the seat is $\alpha + \beta + \gamma$, whereas it is $1 - (\alpha + \beta + \gamma)$ for Party B. The microeconomics foundations for these expected payoffs are described in Appendix A.1.

Finally, there are two types of voters in a given district – "old" voters who voted in the same district in the previous election and "new" voters who voted in another district in the previous election.[19] If there is no redistricting, all voters are "old" voters, whereas there is a mix of "old" and "new" voters in electoral districts whose boundaries have changed since the previous election.

In the basic game without redistricting, there are two stages. In Stage 1, both players

[18]We assume that γ works disadvantageously to Party B if Party B fields a *defeated*. Hence, it is subtracted from Party B's probability of winning a seat. This matches the practice that once a candidate loses his/her seat, then he/she will be most typically replaced with a *fresh*.

[19]We take a similar approach to, and use the same wordings of, some previous studies examining the effects of redistricting on incumbency advantage (Ansolabehere, Snyder & Stewart 2000, Desposato & Petrocik 2003).

simultaneously choose a candidate for the next election.[20] In Stage 2, the election takes place and payoffs are realized. In the extended game, we introduce Stage 0 in which redistricting occurs. As discussed in Section 2, redistricting can be treated as an exogenous shock and it occurs *before* both parties field their candidates. Both parties equally observe redistricting, but they cannot manipulate the process of redistricting.

3.2 Analysis

In this subsection, we first illustrate the basic model in which there is no redistricting, and then analyze how the equilibrium changes when redistricting occurs under two competing hypotheses.

3.2.1 Basic Model

In the basic model, there is no redistricting and hence the game starts from Stage 1. All voters in the electoral district are the same voters from the previous election; namely, "old" voters. The expected payoff to Party A, which depends on the combination of strategies chosen, is given in the appropriate cell of Table 1. The expected payoff to Party B is simply one minus Party A's payoff. Specifically, the expected payoffs to Parties A and B are $(\alpha, 1-\alpha)$ when both field a *fresh*; $(\alpha+\gamma, 1-(\alpha+\gamma))$ when Party A fields a *fresh* but Party B fields a *defeated*; $(\alpha+\beta, 1-(\alpha+\beta))$ when Party A fields an *incumbent* but Party

[20]It is possible to assume a sequential process of candidate selection by two parties with or without complete information. In this paper, we present a basic model that is sufficient to capture empirical patterns. We leave further sophistication of our model for future research.

		Party B: *fresh*	Party B: *defeated*
Party A	*fresh*	α	$\alpha + \gamma$
	incumbent	$\alpha + \beta$	$\alpha + \beta + \gamma$

Table 1: Without Redistricting (Benchmark). *Note: For Party A, which won a seat in the previous election, an experienced candidate is an incumbent candidate, whereas for Party B, which did not, he/she is a defeated candidate. The payoff to Party A is shown in each cell. The payoff to Party B is one minus Party A's payoff.*

B fields a *fresh*; and $(\alpha + \beta + \gamma, 1 - (\alpha + \beta + \gamma))$ when party A fields an *incumbent* and party B fields a *defeated*. Then, Nash equilibrium is that Party A fields an *incumbent* and Party B fields a *fresh* – the left-bottom cell in the matrix of Table 1.

3.2.2 Hypotheses

Our focus is to examine, using the basic model as benchmark, how parties' optimal strategies *change* when Stage 0 (i.e., redrawing of electoral boundaries) is introduced. The key issue with redistricting is that there will be both "new" and "old" voters in the electoral district. Hence, the probability of winning the seat is determined not only by α, β, and γ, but also by two additional parameters, both of which reduce incumbent candidate advantage due to the entry of "new" voters in the electoral district.

First, we introduce m where $m > 0$, which indicates to what extent an *incumbent*'s vote-mobilization ability is weakened by redistricting. Normally, an *incumbent* does not have as much name recognition to "new" voters as to "old" voters. The network of activists who

mobilize votes for the incumbent is also typically less developed in areas with "new" voters.[21] Hence, it makes sense to assume that the incumbent candidate advantage is reduced from β to $\beta - m$ in the post-redistricting district composed of "new" and "old" voters. Hood III and Mckee (2010) present empirical evidence showing that voters are less likely to vote for an incumbents after redistricting if they are less likely to recognize him/her.

We assume, however, that the *incumbent* does not lose his/her electoral advantage entirely in the post-redistricting district. In other words, after redistricting, an *incumbent* still has a positive incumbent candidate advantage but its magnitude is smaller; formally, we assume $\beta > m > 0$. As far as the incumbent's name recognition and the density of supporting networks are concerned, redistricting may weaken his/her advantage in getting votes, but there is no rationale to believe that redistricting turns advantage into disadvantage.

There may be, however, another parameter that would further reduce incumbent candidate advantage, which stems from inflexibility in political position. We denote it by l. Theoretically, in a post-redistricting district, a party should nominate a candidate who can attract not only "old" voters but also "new" voters.[22] However, an *incumbent* who previously pledged (and perhaps implemented) his/her policy to attract "old" voters in the

[21]For a classic study on the roles of social networks in vote mobilization, see Rosenstone & Hansen (1993).

[22]See Besley & Preston (2007) for a model suggesting how electoral redistricting affects political parties' policy-position strategies. Their focus, however, is the impact of partisan bias due to the pattern of redistricting on the governing party's policy choice. Specifically, they argue that redistricting in favor of one party motivates that party to choose policy outcomes favoring its core supporters rather than swing voters. We do not examine the partisan causes and consequences of redistricting, as redistricting is assumed to be politically neutral in Australia. The validity of this key assumption will be tested in Section 4.

pre-redistricting district face difficulty in changing his/her position to meet the new electoral environment. This is because doing so flexibly may negatively affect his/her policy position's credibility and his/her reputation as a trustworthy incumbent.

To elucidate the logic underlying this parameter l, suppose the following hypothetical case. An incumbent won in the previous election by gaining 55% of supports from voters in the pre-redistricting district. The next election is held after redistricting and 10% of voters are "new" voters. It is risky for this incumbent to rely on 55% of support among "old" voters, because in the worst scenario, he/she loses the seat (i.e., $55\% \times 90\%$).[23] Thus, given time and resource constraints, the incumbent must cultivate "new" voters by pledging policy outcomes that favor "new" voters; for example, by promising to upgrade a hospital in the "new" area.[24] This policy shift, however, may have some backlash effects if he/she has to abandon previously committed policy proposals that attracted 55% of "old" voters in the previous election.

There are two significant factors that contribute to the reality of this dilemma for incumbents in the Australian system. First, the two-party preferred seat share has always been close to 50% in Australian Lower House elections. Specifically, in ten Lower House elections

[23]This assumes that 55% of "old" voters continue to support the incumbent.

[24]In the Australian context, political parties (and their leaders) take an initiative in designing policies, but it is by no means odd to assume that candidates still strive to – and are able to – bring geographically-specific pork-barrel benefits to their home constituencies, such as multimillion dollar programs to construct, upgrade, and/or maintain roads, hospitals, bridges and other infrastructure; to improve educational facilities; to support families and children in need; and to promote local economic growth and employment (Denemark 2000, Leigh 2008). For constituency activities by Australian legislators, see Studlar & McAllister (1996).

held between 1984 and 2010, half of the districts had 8.3% or smaller vote margins. More strikingly, in one in ten districts, winners were decided by a margin of 1.5% or smaller. Second, the Australian government maintain tight fiscal discipline: Unlike most other OECD democracies, the government maintained budget *surplus* until recent years. Thus, it is not realistic that parties and candidates ignore fiscal constraints and promise voters to spend as much as possible to attract *both* "old" and "new" voters.

A question is to what extent l reduces incumbent candidate advantage. There are two possible relative magnitudes of parameters. If the parameter l becomes smaller than $\beta - m$ (i.e., $\beta - m - l > 0$), then an *incumbent* still has an advantage in getting votes (**Hypothesis 1**). By contrast, if l happens to be larger than $\beta - m$ (i.e., $\beta - m - l < 0$), then an *incumbent* has a disadvantage (**Hypothesis 2**). These are the two hypotheses we intend to test and we will shortly deduce the equilibrium under each hypothesis.

Before solving the game, we note that Party B is also affected by fielding a *defeated* when redistricting occurs, because he/she has already declared his/her policy to attract "old" voters in the previous election. Since his/her policy was not implemented due to losing in the previous election, he/she is considered to be more flexible in changing the policy position than an *incumbent*. Yet, we assume that a *defeated* is less flexible in policy-position taking than a *fresh*, because, similarly to an *incumbent*, changing his/her policy position may be perceived by "old" voters as a loss of credibility. This disadvantage for Party B (i.e., advantage for Party A) is reflected as δl, where $0 < \delta < 1$.

The post-redistricting problem is represented in Table 2. Note that fielding a *fresh* is a dominant strategy for Party B, and hence the combinations of (*fresh*, *defeated*) and

		Party B: *fresh*	Party B: *defeated*
Party A	*fresh*	α	$\alpha + \gamma + \delta l$
	incumbent	$\alpha + \beta - m - l$	$\alpha + \beta + \gamma - m - l + \delta l$

Table 2: With Redistricting. *Note: For Party A, which won a seat in the previous election, an experienced candidate is an incumbent candidate, whereas for Party B, which did not, he/she is a defeated candidate. The payoff to Party A is shown in each cell. The payoff to Party B is one minus Party A's payoff.*

(*incumbent*, *defeated*) are not realized in equilibrium. We thus check the remaining two possibilities. The expected payoff to Parties A and B are $(\alpha, 1-\alpha)$ when both parties field a *fresh*, while they are $(\alpha+\beta-m-l, 1-(\alpha+\beta-m-l))$ when Party A fields an *incumbent*, but Party B fields a *fresh*.

Hypothesis 1: Incumbency Advantage ($\beta - m - l > 0$) Under Hypothesis 1, we assume that incumbent candidate advantage remains in the post-redistricting district. This is expressed as $\beta - m - l > 0$, which implies β to be large enough, or m and/or l may be small enough. Nash equilibrium under this assumption is that Party A fields an *incumbent* and Party B fields a *fresh*. This is the same equilibrium as the basic model.

Hypothesis 2: Incumbency Disadvantage ($\beta - m - l < 0$) Contrary to the conventional wisdom, we next suppose that incumbency advantage disappears in post-redistricting district. That is, we assume $\beta - m - l < 0$, which implies that β is originally small or m and/or l are/is large. Under this assumption, Nash equilibrium is Parties A and B both

fielding a *fresh* – redistricting brings a negative effect on retaining an *incumbent*.

4 Empirical Test

We have shown two competing hypotheses. If Hypothesis 1 is correct, redistricting has no effect on candidate selection. If Hypothesis 2 is correct, the equilibrium changes and parties' candidate-selection strategies are influenced by redistricting. We first introduce our data and methods and discuss observable implications. We then show the findings.

4.1 Data and Methods

To test the two hypotheses derived in Section 3, we use district-level data of eight Australian Lower House elections held in the past twenty years (in 1990, 1993, 1996, 1998, 2001, 2004, 2007, and 2010). The electoral system used is the preferential voting system with 147–150 single-member districts,[25] and voting is compulsory. Under this voting rule, voters must assign their preferential orders to all candidates. The votes for the candidate with the fewest first-preference votes are transferred to the other candidates according to voters' second preferences. Then, the votes for the remaining candidate with the fewest votes (a total of first and second preferences) are transferred based on voters' third preferences. After the full distribution of preferences, the candidate with more than 50% of the two-candidate-

[25]To be more precise, the number of seats was 148 (in 1990, 1996, 1998), 147 (in 1993), or 150 (in 2001, 2004, 2007, 2010).

preferred vote share wins a seat.[26]

For each district, there are two observations; i.e., one for the winning party (i.e., the "incumbent party") and another for the defeated party in the previous election. As we explained, in most districts, the top two candidates were from the Australian Labor Party (ALP) and the coalition of the Liberal Party (LP) of Australia and the National Party (NP) of Australia. We exclude a small number of new districts created by merging parts of existing districts, as well as districts abolished. In these districts, either the incumbent party status or data after redistricting is missing. We also exclude a small number of districts where the competition by two major candidates in the previous election was not the ALP vs. the coalition. After excluding these districts, the total number of observations for our analysis becomes 2,244 (1,122 districts, 94.2% of all districts).

4.1.1 Treatment Variable and Balance Test

The treatment variable is $Z_{it} \in (0, 1]$, which is the proportion of "old" voters in District i for Election t.[27] If there was no redistricting in State/Territory s before Election t or if the boundary of District i is not influenced by redistricting within State/Territory s before Election t, $Z_{it} = 1$. If a completely new district is created by merging parts of existing districts, $Z_{it} = 0$.[28] In states and territories where redistricting was done during the period

[26]The number of candidates in a district ranged from 2 to 14 (mean = 6.3) in the sample elections.

[27]The data sources are the official reports of redistribution (i.e., redistricting) published by the Australian Electoral Commission (`http://www.aec.gov.au`).

[28]We exclude these cases from our analysis, because the incumbent party status cannot be defined.

of investigation (Table 3), Z_{it} has an intra-state/territory variation. The average of Z_{it} for all observations is 0.924, whereas the average only including states/territories which had redistricting before an election is 0.845 (N =1,122).[29]

There are two important remarks with regard to redistricting in Australian elections. First, as Table 3 shows, redistricting is a fairly frequent event. Within the sample of observations, about a half (48.9%) of districts were influenced by redistricting. This variation in our treatment variable is useful to estimate its causal effect.

Second, as we introduced in Section 2, Z_{it} is an *as-if random* exogenous variable. To test this key assumption, we used a range of pre-treatment variables and examined whether their mean values are different between a *treated* group of districts with redistricting (if $Z_{it} \leq 0.924$, the average of all observations) and a *control* group of districts without redistricting (if $Z_{it} > 0.924$).[30] The pre-treatment variables used in the test, such as measures of partisanship and competitiveness, are variables that would likely correlate with both the treatment variable (redistricting) and the outcome variable (candidate selection) *if the process of redistricting were manipulated by politics*. Specifically, we include the number of candidates in District i in Election $t-1$ (*numcand*) and its squared term (*numcand*^{2}), the

[29]As noted above, there are two observations for District i in Election t: one for the ALP and another for the coalition. The district-specific variables, including Z_{it}, have the same value for any given District i in Election t.

[30]We also tried two additional ways to dichotomize the continuous treatment variable – whether or not $Z_{it} \leq 1$, and whether or not $Z_{it} \leq 0.845$, the average for states/territories with redistricting. The results are very similar. Regardless of the method to dichotomize Z_{it}, all pre-treatment covariates are well balanced.

Year	NSW	VIC	QLD	WA	SA	TAS	ACT	NT
1989		Jun 5		Mar 31				
1992	Jan 31		Jan 28		Jan 17	Apr 1	Mar 23	
1994		Dec 20	Dec 1				Sep 30	
1997			Dec 10	Mar 6			Dec 10	
1999					Aug 13			
2000	Feb 11			Nov 20		Feb 11		Dec 21
2003		Jan 29	Nov 25		Dec 17			Feb 19
2004								Apr 28
2005							Dec 9	
2006	Nov 22		Nov 22					
2008				Dec 18				Sep 19
2009	Dec 22		Dec 15			Feb 16		

Table 3: Date of Redistricting (Final Determination), 1989-2009. *Note: NSW=New South Wales, VIC=Victoria, QLD=Queensland, WA=Western Australia, SA=South Australia, TAS=Tasmania, ACT=Australian Capital Territory, NT=Northern Territory. Lower House elections were held in 1990, 1993, 1996, 1998, 2001, 2004, 2007, and 2010. In 2003, NT did not undergo a Redistribution but reverted to a single division, while in 2004, NT reverted to two divisions. Source: the Australian Electoral Commission.*

winner's vote share in District i in Election $t-1$ (a measure of *closeness*) and its squared term ($closeness^2$), a dummy variable for LP (lp), a dummy variable for NP (np), and a dummy for CLP (clp).[31] Under an assumption that the effects of the two measures of competitiveness (*numcand* and *closeness*) are different depending on which coalition party (LP,

[31]The values of *numcand* and *closeness* are the same for the two observations for any given District i in Election t. One of these two observations is always for the ALP. The Country Liberal Party (CLP) in Northern Territory is affiliated with both LP and NP and is a member of the coalition.

NP or CLP) competes against ALP, we also added interaction terms. Finally, we also added whether or not an observation is for an incumbent party (*inc*), which is used in our main regression model. This variable, however, is balanced by design, because for any District i in Election t, one observation is for the incumbent party and another is for the opposition.

The results are presented in Table 4. The second and third columns show the means and standard deviations for *treated* observations (i.e., districts with redistricting), whereas the fourth and fifth columns show those of *control* observations (i.e., districts without redistricting). The last two columns show t statistics and normalized differences. The recent statistics literature (Imbens & Wooldridge 2009, Imbens & Rubin forthcoming) suggests that the commonly reported t tests are misleading for balance tests, as they are sensitive to the sample size of treated and control observations. A more appropriate scale-free measure of the difference in distribution, which they suggest, is normalized difference ($n.d.$),

$$n.d = \frac{\bar{X}_t - \bar{X}_c}{\sqrt{S_t^2 + S_c^2}} \tag{1}$$

where $\bar{X}_i$ is the sample mean for either $i = t$ (treated) or c (control) and S_i^2 is the sample variance. The last column in Table 4 shows that this difference is very small for any pre-treatment variable included in our analysis. The maximum difference is -0.07, the absolute value of which is much smaller than 0.25, a rule-of-thumb value indicating that linear regression is sensitive to model specification (Imbens & Rubin forthcoming).[32]

By running a probit regression with these pre-treatments as the right-hand-side variables

[32]The CLP dummy and its interaction terms show higher t-statistics, but these results are due to the fact that there are only 9 observations with $clp = 1$ and they are all untreated (i.e., without redistricting).

Pre-treatment	Treated		Control		Difference	
Variables	Mean	S.D.	Mean	S.D.	t	$n.d.$
inc	0.50	0.50	0.50	0.50	0.00	0.00
$closeness$	59.24	6.23	59.12	6.34	0.38	0.01
$closeness^2$	3547.70	763.94	3535.83	773.93	0.33	0.01
$numcand$	6.32	1.96	6.33	1.96	-0.10	-0.00
$numcand^2$	43.82	27.72	43.94	26.56	-0.09	0.00
lp	0.41	0.49	0.43	0.50	-0.77	-0.03
$lp \times closeness$	24.61	29.56	25.55	29.60	-0.68	-0.03
$lp \times closeness^2$	1478.16	1827.12	1528.56	1824.84	-0.59	-0.03
$lp \times numcand$	2.60	3.35	2.76	3.40	-0.99	-0.03
$lp \times numcand^2$	17.95	28.03	19.15	27.81	-0.93	-0.03
np	0.06	0.24	0.05	0.23	0.60	0.02
$np \times closeness$	3.65	14.40	3.27	13.68	0.60	0.02
$np \times closeness^2$	220.50	883.84	197.57	843.82	0.58	0.02
$np \times numcand$	0.39	1.59	0.32	1.44	0.93	0.03
$np \times numcand^2$	2.67	12.49	2.16	11.52	0.93	0.03
clp	0.00	0.00	0.01	0.08	-1.93	-0.08
$clp \times closeness$	0.00	0.00	0.31	4.09	-1.92	-0.08
$clp \times closeness^2$	0.00	0.00	16.83	224.82	-1.91	-0.07
$clp \times numcand$	0.00	0.00	0.03	0.42	-1.84	-0.07
$clp \times numcand^2$	0.00	0.00	0.18	2.64	-1.72	-0.07
propensity score	0.70	0.03	0.71	0.03	-2.81	-0.09

Table 4: Results of Balance Tests. *Note: The number of treated observations is 654, and the number of untreated observations is 1,590. inc=incumbency dummy, close=closeness in the previous election, numcand=the number of candidates in the previous election, lp=Liberal Party dummy, np=National Party, clp=Country Liberal Party dummy. The last two columns show a t-statistic and a normalized difference. The last row shows the difference in propensity scores.*

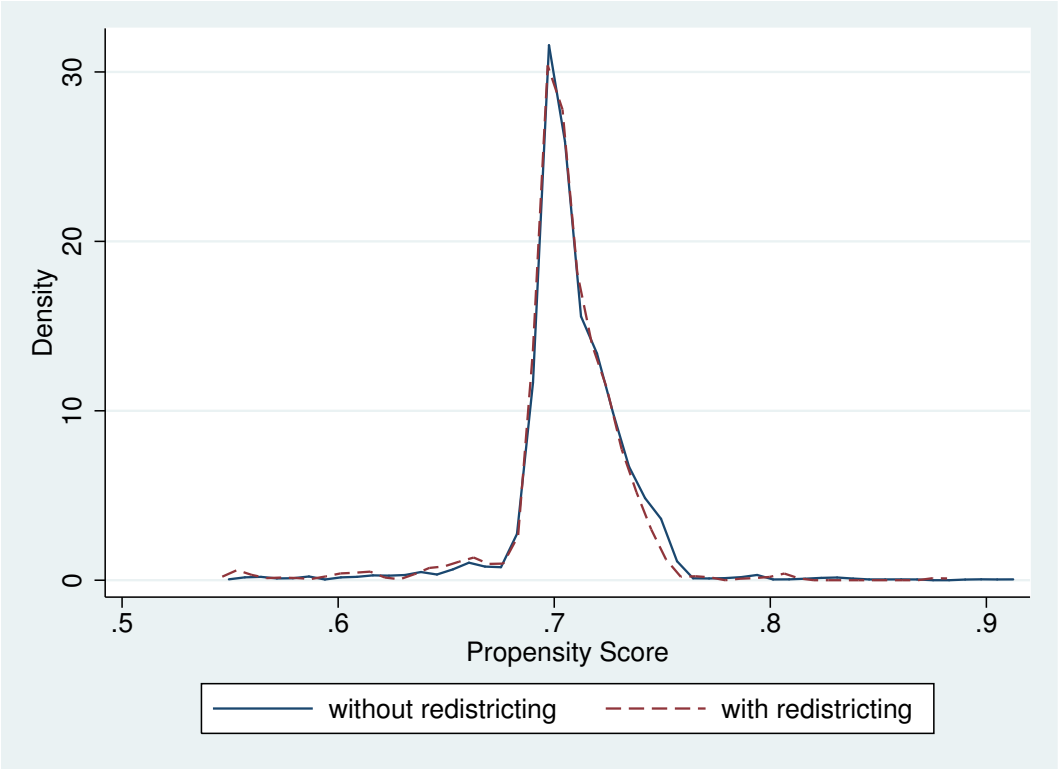

Figure 1: Restuls of Balance Tests. *The figure shows the distribution of propensity scores for treated observations (with redistricting) and control observations (without redistricting).*

and the treatment status as the left-hand-side variable, we also estimated the propensity score – the probability that an observation is treated – for each observation.[33] The last row in Table 4 shows that the average values for treated observations and for control observations are 0.70 and 0.71, respectively, and the normalized difference is only −0.09. Figure 1 shows the distribution of propensity scores for the treated group and that for the control group. As the small normalized difference suggests, these two distributions are almost identical.

[33]As explained in footnote 32, all districts where a CLP candidate competed against an ALP candidate are untreated observations (without redistricting). Therefore, *clp* and its interaction variables are omitted from the probit regression.

In sum, the balance tests suggest that our treatment variable, the percentage of "old" voters in District i in Election t (Z_{it}), is exogenous to pre-treatment political variables. This provides important empirical evidence validating the key assumption in our model that the process of redistricting in Australia is politically neutral.

4.1.2 Outcome Variable and Regression Model

Given our confidence that our treatment variable is exogenous, we now move on to estimating its effect on candidate selection. Specifically, the outcome variable is a dichotomous variable indicating whether a party selected a candidate who had competed in the previous election or a new candidate. Formally, $Y_{ijt} = 1$ if Party $j \in \{\text{ALP, Coalition}\}$ selected an experienced candidate, and $Y_{ijt} = 0$ if Party j selected a fresh candidate, in District i (within State/Territory s) for Election t.

Our theoretical model implies the heterogeneity of causal effects – the impact of redistricting on candidate selection is conditional on each party's incumbency status. Therefore, we interact Z_{it} with an indicator variable for the incumbent party: $I_{ijt-1} = 1$ if Party j won a seat in District i in Election $t-1$, whereas $I_{ijt-1} = 0$ if Party j was defeated.

Finally, we add a set of indicator variables for each state-election, ρ_{st} by considering the fact that each redistricting decision is made within each State/Territory s before Election t. Methodologically, this "blocking" controls any observable and unobservable characteristics that are specific to each s in t. The following model is then estimated by probit regression:

$$P(Y_{ijt} = 1) = \beta_1 Z_{it} + \beta_2 I_{ijt-1} + \beta_3 Z_{it} I_{ijt-1} + \rho_{st} + \epsilon_{ijt} \quad (2)$$

where ϵ_{ijt} is an error term. Since the candidate selection process *within each district* should

be correlated between the two camps, we estimate clustered robust standard errors where clusters are District i in Election t.

The marginal effect of Z_{it} depends on whether a party won a seat in the previous election or was defeated. Formally, they are β_1 if $I_{ijt-1} = 0$ and $\beta_1 + \beta_3$ if $I_{ijt-1} = 1$. The analysis of our formal model implies that redistricting does not change the equilibrium of the two-party simultaneous game if Hypothesis 1 (the assumption that incumbent candidate advantage remains) is true. Therefore, we do not expect to observe any significant effect of Z_{it} in this case.

If Hypothesis 2 (the assumption that incumbency candidate advantage becomes a disadvantage following redistricting) is correct, however, our model suggests that an *incumbent* be replaced with a *fresh* after redistricting. Importantly, this change in the strategy of a party that won a seat in the previous election (Party A) affects the candidate selection of a party that was defeated in the previous election (Party B). This is because, in our simple endogenous candidate selection model, the equilibrium changes from (*incumbent, fresh*) to (*fresh, fresh*). If Party B were not to field a fresh candidate after redistricting, Party B's winning probability would decrease. Therefore, an observable implication of Hypothesis 2 is that Party B is *more likely* to field a *fresh* with redistricting, as compared to the baseline case of without redistricting, in order to increase their probability of winning the seat. In sum, if Hypotheses 2 is correct, we expect $\beta_1 > 0$ and $\beta_1 + \beta_3 > 0$.

In addition to the above model (Model 1), we also estimate an additional model with the pre-treatment covariates, which we used in our balance tests. As they are exogenous, adding these variables should not change the marginal effect of Z_{it} substantially. This is

another informal test of the assumption that the process of redistricting in Australia is not influenced by politics.

4.2 Results

Let us first show the results of a simple but intuitive analysis, which is based on the following procedure. We divided the original 1,122×2 observations into two sets of fifteen equal-sized groups sorted by Z_{it}. One set is for the party that won a seat in the previous election ($I_{ijt-1} = 1$) and another for the party that was defeted ($I_{ijt-1} = 0$). For each group, the average of Z_{it} and the proportion of $Y_{ijt} = 1$ are computed. Then, using these fifteen observations, we run a simple bivariate OLS regression. The results are graphically presented in Figure 2. The right panel shows that for the incumbent party, the effect of the average percentage of "old" voters on the likelihood of nominating the same candidate is positive ($b = 0.31$). This effect is statistically significant at 1% level. (The shaded area shows the 95% confidence interval of prediction.) The left panel shows the correlation for the party that was defeated. The effect is still positive ($b = 0.11$), although it is insignificant and the magnitude of the effect is smaller. These results indicated the validity of our incumbency disadvantage hypothesis (Hypothesis 2).

The estimated results of the model specified in the previous subsection are shown in Table 5. Model 1 does not include the pre-treatment variables used in the balance tests, whereas Model 2 includes them.[34] Figure 3 graphically shows the estimated marginal effects of the percentage of "old" voters on the probability of a party nominating an experienced

[34]Due to perfect colinearity, *clp* and its interaction variables are dropped. Also see footnote 33.

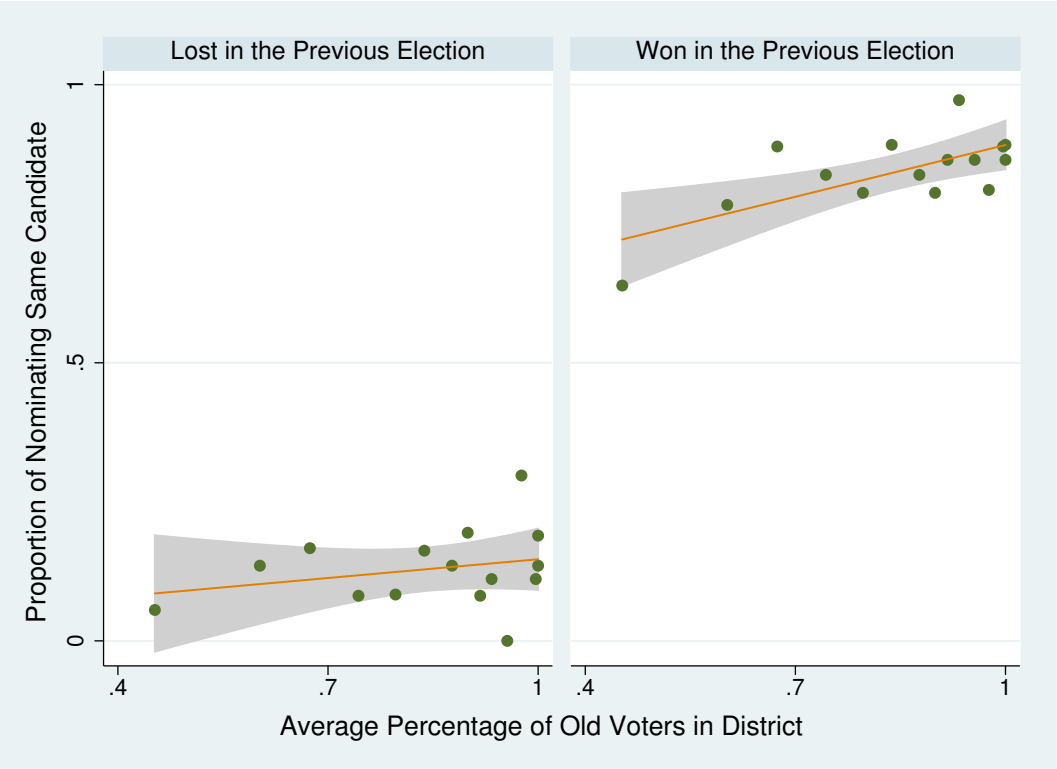

Figure 2: Results of Bivariate Regression. *The dependent variable is the percentage of party fielding the candidate who fought in the previous election, and the independent variable is the average percentage of "old" voters in district. , by Party's Incumbency Status. The original data ($N = 1,098$) include states/territories with redistricting before an election. The candidate-level data are then divided into 15 groups with the roughly equal size, before calculating the dependent and independent variables. The shaded area shows the 95% confidence interval of prediction.*

candidate. The lines indicate the average treatment effect (ATE) and the shaded areas show the 95% confidence interval. All other variables, including state×year fixed effects (ρ_{st}) and/or pre-treatment covariates, are held constant at their means. The top two panels are the results based on Model 1 (without covariates) and the bottom ones are those based on Model 2 (with covariates).

Most importantly, as the first-cut simple analysis already indicated, Table 5 and Figure 3 suggest that the incumbency disadvantage hypothesis has stronger empirical support

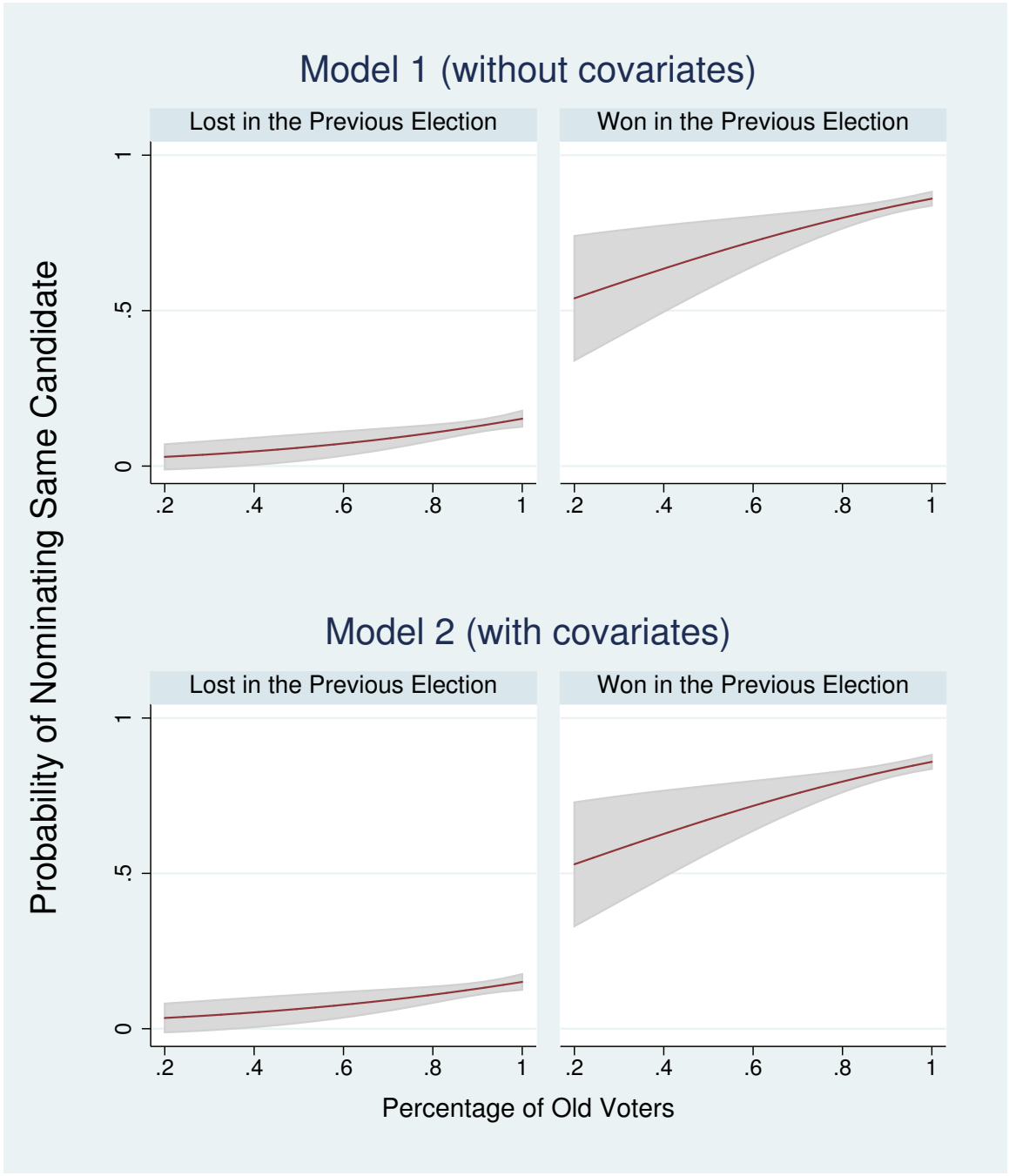

Figure 3: The Predicted Probability that the Outcome Variable is Selected given the Values of the Treatment Variable. *The treatment variable is the percentage of "old" voters in a given district, whereas the outcome variables is whether or not a party selected the same candidate who fought in the previous election. The left figures are for the party that was defeated in the last election, and the right figures are for the party that won. The lines indicate the mean predicted value, and the shared areas indicate the 95% confidence interval.*

Variables	Model 1		Model 2	
$\hat{\beta}_1$ for Z_{it}	1.115**	(0.436)	1.038**	(0.448)
$\hat{\beta}_2$ for I_{ijt-1}	2.029***	(0.468)	1.946***	(0.482)
$\hat{\beta}_3$ for $Z_{it} \times I_{ijt-1}$	0.159	(0.501)	0.290	(0.514)
$\hat{\beta}_1 + \hat{\beta}_3$	1.274***	(0.366)	1.329***	(0.372)
Pre-treatment variables	excluded		included	
Observations	2,244		2,244	
Log likelihood	-902.7		-885.0	
Pseudo R-squared	0.419		0.431	

Table 5: Probit Regression Results. *Note: The estimated effect of the percentage of "old" voters on the probability of fielding an experienced candidate is $\hat{\beta}_1$ for the party that was defeated in the previous election ($I_{ijt-1} = 0$) and $\hat{\beta}_1 + \hat{\beta}_3$ for the party that won the seat in the previous election ($I_{ijt-1} = 1$). The numbers in parentheses are robust clustered standard errors, where clusters are district×year. The model includes state×year fixed effects (coefficient estimates not shown). *** p<0.01, ** p<0.05, * p<0.1.*

than the incumbency advantage hypothesis. The marginal effect of Z_{it} (the percentage of "old" voters) on $P(Y_{ijt} = 1)$ (the probability of fielding an experienced candidate) is 1.115 (Model 1) or 1.038 (Model 2) for the party that was defeated in the previous election. It is 1.274 (Model 1) or 1.329 (Model 2) for the party that won a seat in the previous election. The smaller the percentage of "old" voters in a district (i.e., the larger the magnitude of redistricting), the less likely it is that both parties nominate an experienced candidate (i.e., the more likely that a fresh candidate is nominated). The effects are all statistically significantt.

Figure 3 shows that the marginal effect is larger for the party that won a seat in the

previous election than for the party that was defeated. If a party won a seat in the previous election, redistricting has a large effect on their candidate selection. Specifically, the probability of fielding an incumbent is above 85% when the percentage of "old" voters is 90%. If this percentage drops below 50%, the probability that an incumbent will be able to run for re-election decreases to less than 80%. For a party defeated in the previous election, fielding a fresh candidate is a dominant strategy. Thus, regardless of the magnitude of redistricting (Z_{it}, on the vertical axis), the probability of fielding an experienced candidate (i.e., a repeat challenger) is small. This probability, however, increases as Z_{it} increases and this change is statistically significant. When the winning party changes their strategy after redistricting, the defeated party has a stronger incentive to field a fresh candidate, as well, to maintain their winning probability.

Finally, as we expected, the marginal effects shown in Table 5 are similar between Model 1 and Model 2. The similarity in estimated marginal effects is clearly shown in Figure 3. The top and bottom panels are almost identical. The addition of these pre-treatment variables, which measure partisanship and competitiveness in the previous election, does not affect the marginal effect of the treatment variable, the percentage of "old" voters after redistricting. This is further evidence for the validity of a key assumption in our analysis – the political neutrality of redistricting in Australia.

5 Conclusion

In this paper, we first captured the politics of candidate selection in Australia based on an endogenous candidate selection model, which assumes strategic interactions by the party that won the seat in the previous election and the party that was defeated. With this game-theoretical framework, we examined how the exogenous process of redistricting affects the parties' candidate selection strategy, and derived two hypotheses – the incumbency advantage and incumbency disadvantage hypotheses. Our empirical analysis suggests the validity of the latter. Specifically, incumbents are significantly disadvantaged by redistricting in Australia: the larger the magnitude of redistricting (i.e., the larger the proportion of "new" voters in the post-redistricting district), the more likely that a party that won a seat in the previous election will replace an incumbent with a fresh candidate. The effect of redistricting is also significant for a party that was defeated in the previous election, although the magnitude of the effect is smaller. We emphasize that our estimates are likely to be unbiased because of a unique natural experimental setup in Australia. We detailed the process of redistricting in Australia and, furthermore, showed that pre-treatment political variables are very well balanced, as expected.

We believe that our study makes three contributions to the literature and suggests further research. First, the number of natural experimental studies in political science and economics is increasing rapidly, and a range of topics have been investigated (for reviews, see e.g., Angrist & Pischke 2010, Dunning 2008, Robinson, McNulty & Krasno 2009). Our study, however, is the first to apply a natural experimental design to study candidate selection

in democracy, an important but under-investigated topic. We also argue against a view that recent experimental researchers attempt to find good answers but not good questions. We believe, as Angrist & Pischke (2010) argue, "Good research designs complement good questions" (p. 25). Researchers with theoretically or substantially important but difficult-to-answer questions should direct their eyes beyond the very commonly studied country (i.e., the U.S.) and learn different institutional and historical settings, which may provide useful natural experimental setups.

Second, we provide new insight into the process of candidate selection. If political parties are relatively strong in determining who competes for a seat in an upcoming election, it is more suitable to model candidate selection as an outcome of strategic interactions by parties rather than as an outcome of individual career decisions by candidates. Our study is the first to propose this game-theoretical model of candidate selection with a focus on the Australian case. We believe this model and its extension can be applied to candidate selection in other democracies with strong party discipline. More comparative studies are needed to better understand the important initial step in representative democracy – i.e., the selection of candidates for a legislature.

Finally, as we argued in Section 1, the literature has not fully examined the determinants and ramifications of the composition of a legislature; specifically, the composition of experienced hands and new faces. Our study suggests that an institutional change aimed at achieving the normative principal in democracy – "one-vote, one-value" – can affect this composition: the more frequent and more drastic redistricting decisions are, the more likely fresh candidates get into politics. Examining other determinants of this composition and

discussing the "optimal" composition is, we believe, a significant area of new research in the literature of political economics.

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A Appendix

A.1 Microeconomics Foundation for the Expected Payoffs

We denote N, the vote ratio of the "old" area that remained in post-redistricting district; $F(N)$, the distribution of N which follows uniform distribution $\left[\underline{N}, \overline{N}\right]$; κ, the vote ratio of the "new" area in the post-redistricting district; φ_O, the probability of winning in the electoral district before redistricting (does not include the "new" area), and φ_N the probability of winning in the electoral district after redistricting (includes the newly added area and excludes the area which disappeared in the redistricting). For simplicity, we assume that the vote ratio in the "new" area added to the district is always fixed at κ.

A party needs more than fifty percent of the shares in the given district.

$$\varphi_O = 1 - F(0.5) = \frac{\overline{N} - 0.5}{\overline{N} - \underline{N}}.$$

$$\begin{aligned}
\varphi_N &= 1 - F\left[\frac{0.5 - (1-\omega)\kappa}{\omega}\right] \\
&= \frac{\overline{N} - \frac{0.5-(1-\omega)\kappa}{\omega}}{\overline{N} - \underline{N}} \\
&= \frac{\overline{N} - 0.5 - \frac{0.5-0.5\omega-(1-\omega)\kappa}{\omega}}{\overline{N} - \underline{N}} \\
&= \frac{\overline{N} - 0.5}{\overline{N} - \underline{N}} - \frac{\frac{0.5-0.5\omega-(1-\omega)\kappa}{\omega}}{\overline{N} - \underline{N}} \\
&= \varphi_O - \frac{0.5 - 0.5\omega - (1-\omega)\kappa}{\left(\overline{N} - \underline{N}\right)\omega} \\
&= \varphi_O - \frac{0.5(1-\omega) - (1-\omega)\kappa}{\left(\overline{N} - \underline{N}\right)\omega} \\
&= \varphi_O - \frac{(0.5-\kappa)(1-\omega)}{(\overline{N} - \underline{N})\omega}.
\end{aligned}$$

Then,

$$\begin{aligned} & \varphi_N - \varphi_O \\ = \; & \varphi_O - \frac{(0.5-\kappa)(1-\omega)}{(\overline{N}-\underline{N})\omega} - \varphi_O \\ = \; & \frac{(\kappa-0.5)(1-\omega)}{(\overline{N}-\underline{N})\omega}. \end{aligned}$$

$$\begin{aligned} \frac{\partial(\varphi_N-\varphi_O)}{\partial\kappa} \; & > \; 0 \\ \frac{\partial(\varphi_N-\varphi_O)}{\partial\omega} \; & \gtreqless \; if \; and \; only \; if \; \kappa \lesseqgtr 0.5. \end{aligned}$$

Thus, if we take the example of the basic model, the expected payoff $(\alpha, 1-\alpha)$ can be expressed as $(\varphi_{O1}, 1-\varphi_{O1})$. Similarly, the expected payoff $(\alpha+\gamma, 1-(\alpha+\gamma))$ can be expressed as $(\varphi_{O2}, 1-\varphi_{O2})$, $(\alpha+\beta, 1-(\alpha+\beta))$ as $(\varphi_{O3}, 1-\varphi_{O3})$, and $(\alpha+\beta+\gamma, 1-(\alpha+\beta+\gamma))$ as $(\varphi_{O4}, 1-\varphi_{O4})$.

q.e.d.