Electoral Systems and Geographic Representation

Leonardo Carella[†]

Andrew C. Eggers[‡]

Abstract

Who gets represented in legislatures, and how does this depend on electoral institutions? Others have asked this question from the perspective of gender, race, and class; we focus on *space*, asking whether MPs disproportionately come from some places rather than others and how this depends on electoral rules. Using data on over 13,000 legislators in 62 democracies, we develop a new measure of the extent to which the spatial distribution of MP birthplaces matches the spatial distribution of the citizens they represent. Contrary to received wisdom, we find that single-member district systems do not have more geographically representative parliaments than multi-member district systems, while mixed-member systems perform significantly better than both. We attribute the higher spatial representativeness of mixed-member systems to contamination effects in their single-member tier, and we present evidence for this explanation from within-country analysis of elections from Italy, the UK and Germany.

Keywords

Electoral systems, representation, legislatures, political geography, mixed-member systems.

[†]Mansfield College and University of Oxford. email: `leonardo.carella@mansfield.ox.ac.uk`
[‡]University of Chicago. email: `aeggers@uchicago.edu`

1 Introduction

One of the key insights of the literature on political elites is that compositional differences between the demographic makeup of representatives and that of their voters have important consequences for the quality of democratic representation (Bratton and Ray, 2002; Preuhs, 2005; Carnes, 2012). While comparative scholarship in this field has made substantial advances in mapping representational gaps along the dimensions of gender, race and class origins, this paper aims to investigate *to what extent legislatures around the world reflect the geographic diversity of the voters they represent.* We do so by developing and computing a comparable measure of inequalities in the descriptive representation of *places* in parliaments, the Spatial Un-Representativeness of Legislatures Index (SURLI). Alongside this descriptive exercise, we theorise and investigate how electoral systems may explain cross-country variation on this variable, drawing on the common finding in the descriptive representation literature that different electoral institutions produce distinct opportunities for social groups to access political offices.

Our theoretical starting point is the observation that voters want to have representatives with local ties (Shugart, Valdini and Suominen, 2005), perhaps because they assume that a local candidate is more likely to share their preferences (Shugart, Valdini and Suominen, 2005; Campbell and Cowley, 2014; Cowley, 2013). The pool of potential candidates – those with the social connections, political experience, expertise, and motivation to be in politics – may be geographically skewed, with e.g. more potential candidates from prosperous urban centers than rural areas. Whether the elected legislature is similarly skewed depends in part on how much parties anticipate voters' preference for locals in choosing candidates, as well as how much voters are able to select locals among the competing candidates. Both of these factors depend in turn on the electoral system. Below we offer a theoretical lens through which to view the relationship between electoral systems and the geographical representativeness of legislatures. We also empirically investigate this relationship focusing on two aspects of variation in electoral systems: constituency structure and ballot structure (Reeve and Ware, 2013). We offer evidence of a relationship between electoral systems and geographical representativeness using both a cross-country analysis and within-country analysis in Italy, Britain, and Germany.

To briefly preview our findings, we observe that (perhaps surprisingly) single-member (SM) district systems do not have more geographically representative legislatures than multi-member (MTM) district systems. Although the large number of districts in SM district systems would ensure a representative legislature if parties fielded local candidates in each district, parties may not have much incentive to do so, especially in safe districts. We do find, however, that mixed-member (MXM) systems (i.e. those in which candidates compete both in single-member districts and multi-member districts) tend to have more geographically representative legislatures than either of those systems; we suggest this may reflect the incentives created by spillovers between tiers, which tend to heighten the incentives for parties to field a local candidate, and increase the opportunities for voters to select one, in the nominal (SM) tier. Our analysis of electoral reforms in Italy and of constituency MPs in Britain and Germany provides evidence consistent with this hypothesis.

One of our main contributions is a new, cross-nationally comparable measure of legislatures' geographical representativeness, which we call the Spatial Un-Representativeness of Legislatures Index (SURLI). The basis of SURLI is the discrepancy between the distribution of legislators' birthplaces[1] and the distribution of citizens' residences, measured using the Earth Mover's Distance (Lupu, Selios and Warner, 2017) (equivalent to the 1st Mallows distance or 1st Wasserstein distance). Put simply, this captures the minimum amount of travel necessary to send an equal number of citizens to each MP birthplace. To make SURLI comparable across countries, we express SURLI as the ratio of the true EMD in a country to the expected EMD for that country if MPs were chosen from the population at random. Thus a SURLI of 2 for a given country means that the discrepancy between the distribution of MP birthplaces and the distribution of citizen residences in that country is twice as large as we would expect to arise by chance. Comparing the actual discrepancy in a country to a hypothetical discrepancy in that same country helps address cross-country differences in land area, population distribution, assembly size, and other factors.

The paper is structured as follows. In section 2 we locate our work in the context of existing scholarly works on political geography, electoral behavior and descriptive representation. In section 3 we discuss theoretically the possible channels through which features of electoral systems

[1] As we explain below, we use MPs' birthplaces (rather than e.g. the place they lived the longest as an adult) mostly for practical reasons.

might influence how places are represented in a legislature. Section 4 tests these expectations on a cross-country sample and presents this paper's main empirical contribution: the measurement of SURLI for 62 legislatures, and the results of a cross-country regression that describes how it varies across electoral systems. In Section 5, we carry out two separate within-country analyses: first, we leverage electoral system change in Italy to compare indicators of spatial representativeness across systems and tiers in the same polity; second, we compare British and German constituency legislators, to explore why single-member districts may be more likely to produce local MPs in mixed systems than in single-member systems. Section 6 concludes by discussing briefly the normative implications of the study, its limitations, and further avenues for this research agenda.

2 Related literature

Early democratic theorists worried about the 'problem of space' (Minicucci, 2001): how large representative democracies could aggregate disparate interests of communities located far apart, avoiding risks of secession or domination of one subunit over the other. Indeed, the territorial segmentation of the electorate in constituencies was often justified explicitly on the grounds that it would improve the quality of representation via the *localness* of candidates (Rehfeld, 2005). For instance, Montesquieu in *The Spirit of Laws* (1748) highlights the advantages of local deliberation for selecting representatives:

> One knows the needs of one's own town better than those of other towns, and one judges the ability of one's neighbors better than that of one's other compatriots. Therefore, members of the legislative body must not be drawn from the body of the nation at large; it is proper for the inhabitants of each principal town to choose a representative from it. (Montesquieu, 1989, (1748) p. 159)

In a similar vein, Alexander Hamilton in *Federalist 36* (1788) touches on how representatives' local ties and knowledge enhance the responsiveness of the centre to the peripheries' needs, thus improving democratic outputs:

> If any question is depending in a State legislature respecting one of the counties,

> which demands a knowledge of local details, how is it acquired? No doubt from the information of the members of the county. Cannot the like knowledge be obtained in the national legislature from the representatives of each State? (Hamilton, Madison and Jay, 2008, (1788) p. 169)

Even as national parties have emerged and cleavages based on class and religion have become more salient, the notions of *democratic* and *territorial* representation have remained tightly linked in the electoral institutions of modern states. Non-geographical ways of dividing voters into distinct constituencies (such as the class franchises in 19th-century Prussia and Austria or Zimbabwe's 'white rolls') have always been rare and are almost unheard of in contemporary democracies.[2] Apart from a few countries including Israel and the Netherlands, geographically-disjoint electoral districts remain basic building blocks in every national electoral system. Thus we can still say, with Rehfeld (2005, p. 3), that "in almost every democracy in the world, citizens are represented by where they live."

Correspondingly, *localness* continues to be an important prism through which voters evaluate candidates, as well as an electoral resource that candidates can count on in places where they have built long-standing personal and political networks. The electoral bonus candidates receive in 'their own beat' was famously described by Key (1949, p. 38) in *Southern Politics*:

> A candidate for governor normally carries his own county by a huge majority, and the harshest criticism that can be made of a politician is that he cannot win in his own beat or precinct. If his friends and neighbors who know him do not support him, why should those without this advantage trust a candidate?

There is substantial scholarly agreement that candidates receive an electoral boost in places to which they have personal ties. Evidence in this direction abounds, from spatial ecological studies (Rice and Macht, 1987; Garand, 1988; Gimpel et al., 2008), experimental studies (Campbell and Cowley, 2014; Roy and Alcantara, 2015; Panagopoulos, Leighley and Hamel, 2017), and voter-level survey data (Johnson and Rosenblatt, 2006; Arzheimer and Evans, 2012, 2014; Evans et al., 2017). Strong evidence for voters' preference for local representatives was found in early research

[2] Hong Kong's 'functional constituencies' are a notable exception.

in the United States (Rice and Macht, 1987; Garand, 1988; Gimpel et al., 2008) and Ireland (Gallagher, 1980; Marsh, 2007; Górecki and Marsh, 2012). More recently, research in the United Kingdom shows that voters care far more about candidates' localness than their biological sex (Campbell and Cowley, 2014) or class, religion, and race (Cowley, 2013)[3]. Similar evidence is found in Japan (Horiuchi, Smith and Yamamoto, 2018), Canada (Roy and Alcantara, 2015; Blais and Daoust, 2017), Estonia (Tavits, 2010) and Norway (Fiva, Halse and Smith, 2018).

In contemporary scholarship, voters' preference for local representatives is generally disaggregated into a *behavioral* and a *perceptual* component (Evans et al., 2017). The behavioral component refers to a greater ability of candidates to mobilize supporters in their immediate social networks, including those who live in the immediate surroundings of the candidate's place of residence (Górecki and Marsh, 2012). The perceptual component describes how localness serves as a heuristic for candidate desirability in voters' considerations: in low-information environments, someone from 'around here' can be more easily assumed to understand the community and share its inhabitants' preferences than a 'parachuter' or a 'carpetbagger' (Campbell and Cowley, 2014). In this sense, the micro-foundational mechanism is a form of in-group bias (Panagopoulos, Leighley and Hamel, 2017, pp. 867-868).

Candidates are aware of voters' preference for localness, and some go to great lengths to cue their local credentials to voters. For instance, in a particularly striking example from the 2017 UK General Election, the Green Party candidate in Brent Central distributed campaign literature stating "I am a life long Brent resident, conceived in Harlesden, born in Kilburn, grew up in Queens Park and now reside Willesden" (Milazzo and Townsley, 2018, p. 10).

Do politicians with local ties to a certain locale make for better representatives for that area? The evidence is mixed. Carozzi and Repetto (2016) find evidence from Italy (1994-2004) of pork-barrel spending driven by legislators born *outside* of their district in favor of their municipality of birth; Jennes and Persyn (2015, p 189) find that between 1995 and 2010 "per capita cash transfers to a Belgian electoral district are significantly higher for every federal minister originating from that electoral district". But there are also null findings in the literature. For instance, Fiva, Halse and Smith (2018) leverage close elections in Norway between 1953 and

[3] See also Arzheimer and Evans (2012), Arzheimer and Evans (2014), and Evans et al. (2017).

2013, and find that representatives do *not* increase the level of investment in their hometown; Sällberg and Hansen (2019) find that localness was unrelated to the number of constituency mentions in the UK House of Commons over the 2015/2016 constituency session. Hence – as with other aspects of the 'politics of presence' (Preuhs, 2005) – the literature suggests that descriptive representation does not automatically translate into policy representation, but rather the relationship can be contextual and contingent on institutional factors.[4]

Furthermore, this paper draws on comparative work on the relationship between electoral institutions and descriptive representation in legislatures. In this literature, proportional representation is often found to be conducive to demographically more balanced legislative assemblies. For instance, as far as the gender gap in political representation is concerned, "one of the most stable results in empirical research is that the election of women is favored by electoral systems with party lists, proportional representation (PR), and large district magnitudes" (Wängnerud, 2009, p. 54). PR systems seem to be also more inclusive of younger members of parliament (Joshi, 2013) and to improve *policy* representation of low-income citizens (Carnes and Lupu, 2015). Existing evidence on the effect of electoral systems on ethnic minority representation (Kostadinova, 2007; Moser, 2008; Wagner, 2014) is less clear-cut. Cross-national findings on electoral systems and the descriptive representation of *places* is scarce, not least due to the absence of comparable spatial measures of representational inequalities. Pedersen, Kjaer and Eliassen (2007) analysed the approximate level of *parachutage* – defined as the share of MPs residing outside the district at the time of election – in thirteen Western European countries, finding no clear association with electoral institutions. Perhaps the most influential work in this area is theoretical: Matthew Shugart and colleagues developed a series of models to derive candidates' incentive to seek a personal vote – and thus the likelihood of representatives being local – as a function of, among other factors, electoral rules. Their work suggests that the probability of a representative being local declines with district magnitude in closed-list PR, but increases with district magnitude in open-list PR systems (Shugart, Valdini and Suominen, 2005; Carey and Shugart, 1995). André, Depauw and Shugart (2014) tested these hypothe-

[4]This paper is necessarily agnostic about the desirability of the descriptive representation of places: while – as noted – local ties are highly prized by voters, we do not assess here if voters are 'correct' in preferring legislators with local ties. For some insightful normative considerations on the matter, see Childs and Cowley (2011).

ses in three open-list PR countries (Finland, Luxembourg, Switzerland) and three closed-list PR (Spain, Portugal, Norway), and confirmed that the share of representatives who had held previous local office in the district varies as predicted.

3 Theory

How might electoral institutions affect geographical representation? Our theoretical starting point is that voters throughout a country would prefer, *ceteris paribus*, legislators with strong ties to their local area. (The previous section summarizes comparative evidence that voters prefer local candidates and discusses why this might be true.) We assume, following Gimpel, Lee and Thorpe (2011), that potential candidates (i.e. people with the motivation and opportunity to compete for a seat in parliament) disproportionately have geographical links to certain types of places, such as urban centers. Whether the set of people actually elected to the legislature reflect the geographical skew of the candidate pool depends in part on how elections work. Electoral institutions are, we suggest, an important factor determining the extent to which (1) viable seat-winning parties are motivated to field local candidates throughout a country (*party incentives*), and (2) voters are able to select locals over non-locals as their representatives (*voter leverage*). In this section, we assess how these two criteria may vary depending on two dimensions of variation in electoral institutions:

— *Constituency structure* refers to the districting arrangements that define the geographical areas within which votes are translated into seats (Reeve and Ware, 2013; Shugart and Taagepera, 2017). The traditional distinction is between single-member (SM) and multi-member (MTM) systems: in the former, the votes in each constituency count towards the election of one representative; in the latter, they contribute to the election of more than one, up to the limit case where all MPs are elected from the same nationwide district. A third type of constituency structure has become prominent since the 1990s: mixed-member (MXM) systems. These entail two spatially overlapping tiers each electing a share of the assembly's legislators: one constituted by single-member (the nominal tier) and one by multi-member districts (the list tier).

— *Ballot structure* has been used to describe a range of options that voters have in making their choice in the polling booth. For the purposes of this analysis, we focus on a single key aspect: the presence or absence of *preferential voting* (PV), defined here in terms of any mechanism that allows voters to express a preference for a candidate that is meaningfully different from a preference for a party (Marsh, 1985; Farrell and McAllister, 2006). In single-member districts, parties field one candidate, so these never entail PV. Multi-member districts fall in the same category if they employ a closed-list system, whereby the party presents voters with an ordered list of candidates, and those in positions from 1 to n are elected, where n is the number of seats allocated to that party in the district. Conversely, under PV rules, voters can affect the intra-party allocation of seats: either by voting for candidates *as well as* parties, and thereby changing the candidate ranking in a list system (e.g. Finland's open-list ballot), or by voting only exclusively for candidates in a non-list system (e.g. Ireland's single transferable vote ballot).

We begin by considering parties' incentives to field local candidates in a given district: fielding local candidates is neither necessary nor sufficient to achieve a nationally representative legislature,[5] but it is clearly an important ingredient. We assume that fielding local candidates tends to attract votes to a party, but that it also has a cost to the party: more so than voters, party insiders know about and care about attributes of candidates other than their geographical ties, such as their loyalty to the party, the quality of their policy ideas, their potential to occupy leadership roles, or their personal connections to influential insiders. Because prioritizing local candidates to satisfy voters may mean sacrificing something else a party cares about, it can be seen as similar to turnout mobilization or geographically targeted pork barrel spending: costly to the party, but potentially electorally rewarding. Electoral institutions matter, in this view, because they shape the electoral rewards parties stand to gain from fielding local candidates. In particular, assuming that parties want to win seats, the rewards of fielding a local candidate depend on (1) how fielding local candidates affects a party's vote share (the localness-to-votes link), and (2) how a change in a party's vote share affects that party's seat share (the votes-

[5] With high malapportionment or geographically large districts, a legislature could be geographically unrepresentative even if all districts are represented by locals. Conversely, a legislature could be nationally representative if each district is represented by an MP from another district.

to-seats link) (Cox, 2015). We also consider how electoral institutions shape *voter leverage*, by which we mean voters' ability to translate their preference for locals into electoral outcomes once candidate selection is realised.

3.1 Single-member and multi-member districts

Compared to multi-member (MTM) districts, single-member (SM) districts are often thought to foster normative expectations of a close relationship between legislators and the districts they represent: the smaller the constituency a legislator is directly accountable to, the more visible and accessible she will be to voters (Wessels, 1999) and the more the candidates' personal characteristics (including localness) may matter to electoral success (Curtice and Shively, 2009; Cain, Ferejohn and Fiorina, 2013). Politics in SM systems also tends to be more particularistic, which may encourage voters to prioritize having a representative who is likely to understand local needs and to care about satisfying them. It follows that replacing a non-local candidate with a local candidate in the SM case would affect voting results more than replacing a non-locally representative list with a locally-representative one in the MTM case.

The impact of the electoral system on the translation of votes to seats is more ambiguous. Here we follow Cox, Fiva and Smith (2016), who note an important difference between SM and MTM elections. In a SM district election that is expected to be close, a party might hope to pick up a seat by fielding a local candidate instead of a non-local candidate; in a lopsided SM contest, fielding a local candidate will not affect which party wins the seat, even if it wins some votes. In MTM elections, by contrast, a shift in support has roughly the same probability of changing the allocation of seats regardless of how even or lopsided the expected result is. The expected benefit of winning additional support from 'localist' voters in terms of seats may thus be largest in a competitive SM district, smallest in a safe SM district, and intermediate in a MTM district.

Combining the localness-to-votes step and the votes-to-seats step, we conclude that party incentives to field local candidates are highest in competitive SM districts: voters in SM elections respond to localness, and parties competing in tight races are eager to win any marginal support they can. Local representatives may however be very rare in safe seats, where the leading party has almost no incentive to field a local and may even deliberately 'parachute' a preferred candidate from elsewhere (Pedersen, Kjaer and Eliassen, 2007). MTM districts are an intermediate case: while localist voters are comparatively fewer here, their votes can never be fully discounted, as even marginal increases in vote share translate into marginal increases in expected seat shares. Therefore, whether an SM system *in aggregate* favors the selection of local candidates relative to a MTM system would depend in part on the mix of competitive and safe seats in the SM system.

If presented with both local and non-local candidates, voters in an SM election can influence the outcome only if the election is competitive; thus voter leverage is high in the same districts where parties have a strong incentive to field a local candidate. In MTM systems, the extent of voters' leverage is largely dependent on ballot structure. An MTM system that allows preferential voting – for instance, through open lists or multi-winner ranked choice voting – offers a way for voters to express their preference for locals (however slight) within a party slate (Renwick and Pilet, 2016; Passarelli, 2020). Preferential voting may thus lead to more geographically representative delegations of MPs than under closed-list systems, where voters cannot change the candidate ranking chosen by the party.[6]

Mixed-member systems

Mixed-member (MXM) systems offer voters a chance to elect MPs in both a single-member nominal tier and a multi-member list tier (Shugart and Wattenberg, 2001). If we consider these tiers as separate entities, we might expect legislatures in mixed systems to have an intermediate level of geographic representativeness between SM and MTM systems. When we consider possible "contamination effects" between the two tiers (Herron and Nishikawa, 2001; Cox and Schoppa, 2002; Ferrara, Herron and Nishikawa, 2005; Ferrara and Herron, 2005), however, we

[6]This stylized framework does not fully account for the range of variation and idiosyncrasies of electoral institutions. Notably, our framework is not ideal to accommodate the US case, where – in spite of generally low-competitiveness SM district elections – parties' control over candidate selection is severely limited by institutionalized primaries. Empirically, as in our sample there is no other case where all parties use primaries for candidate selection, we treat the US as an 'ordinary' type of SM system in the main model (table 3). However, it might be possible to think about US-style primaries in terms of a form of preferential voting device in SM systems, where within-party candidate selection is realized *prior to the election* and the choice is limited to only a subset of voters. When we drop the US from the sample in a robustness check of the main model (table 15 in the Appendix section C), the substantive interpretation of results is unchanged.

see reason to doubt that MXM systems are simply a convex combination of SM and MTM systems.

There is fairly robust evidence that voters' vote choices in the nominal (SM) tier of an MXM system affect their vote choices in the MTM, producing contamination effects. For instance, Hainmueller and Kern (2008) show that winning an SMD seat in Germany increases a party's support in the list tier. Ferrara (2004) finds that the placement of SMD candidates affiliated with a party running as part of a pre-electoral coalition boost that *party*'s performance in the PR tier. Qualitative interviews also suggest that parties take cross-tier spillovers into account in crafting their campaign strategies; for instance, a Lithuanian party leader quoted in Ragauskas and Thames (2020, p. 8) noted that the party encourages candidates to "campaign for themselves, not even directly for the party, because personal success spills over to list success .... If people vote for the SMD candidate, they will also vote for the list."

To the extent that vote choices in the nominal tier (SM) affect vote choices in the list tier (MTM), parties have a greater incentive to field local candidates in the nominal tier than they would in a similar district in a purely SM system: fielding a local candidate in the nominal tier could increase a party's chances in both tiers. Crucially, this is true even for parties that are very likely to win the SM seat: it will not affect the SM result in that case, but fielding a local candidate could win the party additional support (and thus possibly an additional seat) in the MTM tier and will result in a local candidate being elected in the SM tier. A locally less competitive party could also gain list-tier seats by fielding a local candidate (or any candidate) in the nominal tier; this may not directly lead to a local candidate being elected, but it may intensify competition in the nominal tier, thus further increasing the incentive for the more competitive parties to field local candidates. Contamination effects in MXM systems thus make it more likely that parties field candidates in the nominal tier, that those candidates are locals, and that competition is close enough that the localist vote can be decisive; all of these factors could make the nominal tier of MXM systems more geographically representative than SM systems.[7]

[7]Contamination effects could also make voters *less* responsive to local-ness in the list tier. If so, MXM systems would be more geographically representative than pure SM or MTM systems only to the extent that contamination effects increase representativeness in the SM tier more than they decrease it in the MTM tier.

		Party incentives to select local candidates		
		Low	Moderate	High
Voter leverage (ability to express a preference for locals)	High		MTM seats with PV (in both MTM and MXM systems)	competitive seats in SM systems SM tier in MXM systems
	Low	safe seats in SM systems	MTM seats without PV (in both MTM and MXM systems)	

Table 1: The probability of a district electing local candidates is increasing in (1) party incentives to elect local candidates and (2) voter leverage. PV = preferential vote, SM = single-member, MTM = multi-member, MXM = mixed-member.

In principle contamination effects could also flow in the other direction, with parties fielding more geographically representative lists in order to win votes in the nominal tier. The literature has mainly focused on contamination from nominal to list tier, but so-called 'reverse contamination' (e.g. Krauss, Nemoto and Pekkanen, 2012) would also enhance the incentive to field local candidates in the list tier, especially in the presence of preferential voting (PV) mechanisms.

3.2 Summing Up

In this section, we have assessed a number of theoretical considerations to take into account in predicting the probability that a district has a local as its representative (or one of its representatives). Table 1 summarises how different types of districts fare according to our criteria of *party incentives* and *voter leverage*. There are a number of countervailing considerations to take into account for each of the types of constituency structure considered, so that in aggregate we have few unambiguous theoretical expectations on their relative performance. The question of electoral systems and spatial representativeness remains therefore primarily an empirical one, which we will seek to address empirically in the following sections. Our theoretical review does, however, yield some tentative priors on the aggregate level of spatial representativeness of legislatures under different electoral rules:

1. The probability of districts expressing local candidates is most uneven in SM district systems, which combine the most favourable context for local representation in competitive districts with the least favourable setting in safe districts. Therefore, the performance of SM systems should be highly contingent on a 'political' factor relatively independent from the formal features of the electoral systems: levels of seat competitiveness. A SM district system thus may be more or less geographically representative than MTM or MXM systems, depending on the distribution of competitiveness across districts.

2. Conversely, because of contamination effects, we expect that the single-member district tier of MXM systems *should* make a positive contribution to overall representativeness relative to MTM districts. Not only should there be relatively few 'safe' seats in the nominal tier, but party incentives to field local candidates remain substantial in all single-member districts, regardless of seat marginality. Therefore, MXM systems should yield more representative legislatures than MTM systems, as their additional single-member tier comprises districts where the likelihood of local representation is high.

3. Within multi-member districts (both in MTM and MXM systems), the presence of preferential voting mechanisms should increase spatial representativeness of legislatures.

4 Cross-Country Analysis

We proceed to test these theoretical expectations on a sample of legislatures from 62 democratic countries, for which we measure our Spatial Unrepresentativeness of Legislatures Index (SURLI) from data on MPs' and population spatial distributions. These data are described in subsection 4.1, alongside other country-level variables that we use to capture variation in electoral institutions and other socio-political variables in the sample. Subsection 4.2 presents the methodology we use to produce our measure of SURLI. Finally, subsection 4.3 discusses the results of cross-country analysis assessing how SURLI relates to electoral system features.

4.1 Data

4.1.1 Legislator Data

To measure the extent to which legislators' local ties are representative of the population, we gathered legislators' birthplaces at a single point in time for 62 legislatures in democratic countries. We chose to focus on politicians' birthplaces because these are often an important indicator of geographical ties (e.g. the case of the Green Party candidate for Brent Central mentioned above) and because it is by far the most practical measure of legislators' local ties to collect on a broad scale. Ideally, we might assess various other measures of politicians' local ties, such as where they grew up or where they spent most of their adult lives. Indeed, previous studies have measured MPs' local ties using their residence (Pedersen, Kjaer and Eliassen, 2007) or previous local office (Shugart, Valdini and Suominen, 2005; André, Depauw and Deschouwer, 2014) in addition to their birthplaces. Each of these studies examines only a handful of Western European countries, however, whereas we aimed to cover a much larger and more diverse set of countries. We therefore focused on gathering birthplace data, which (although certainly an imperfect measure of local ties[8]) is uniquely defined for each MP and is available from official biographies and Wikipedia pages for legislators in many countries.

As our source for legislator birthplaces we rely primarily on data from the Global Leadership Project (GLP) (Gerring et al., 2014) and focus exclusively on lower-house members. The GLP dataset we used includes biographical facts about over 38,000 MPs and other top officials in 145 countries, typically as of 2010 or 2011; much of this data was collected from official government websites. Crucially the GLP includes politicians' birthplaces, recorded as text strings. Coverage of birthplaces in the GLP ranges widely, with many cases near 100% coverage and others (including Portugal, Ireland, Jamaica, and Romania) much lower. We undertook substantial effort to collect birthplaces in cases where they were missing in the GLP; we also checked and corrected the variable identifying legislators to distinguish legislators from unelected cabinet officials and party leaders who did not have seats in the legislature. We supplemented the GLP data with original data collection for six other legislatures: Cape Verde, Chile, Cyprus,

[8] Other measures of local ties have their own shortcomings. Official residence can be changed and may not indicate local connections (Pedersen, Kjaer and Eliassen, 2007), and one can have substantial local ties without holding a local office.

Macedonia, Montenegro, and Taiwan. After filling in missing entries where possible and editing entries that were insufficiently precise (e.g. referring to regions rather than municipalities of birth), we excluded foreign-born legislators and geocoded birthplaces using the Google Maps API. Figure 1 lists the countries we analyze and provides information on data completeness for each one: for most legislature-years, we have valid birthplaces for over 90% of legislators.[9] In terms of case selection, we started with the list of all democracies – countries rated free or partly free in Freedom House (2012) – and proceeded to exclude countries for which, between the GLP and our own efforts, we were not able to obtain a sufficient proportion of MP birthplaces.

4.1.2 Population Data

We next need data characterizing the spatial distribution of the population, which we will compare to the spatial distribution of legislator birthplaces. Here we face a normative judgment. Should a legislature be considered representative if its legislators' birthplaces match the distribution of citizens' *residences*, or the distribution of citizens' *birthplaces*? The former approach assesses whether people living in different places have the same chance of being represented by a local MP; the latter approach assesses whether people born in different places have the same chance (unconditionally) of becoming an MP. Both approaches have merit, so we gather data to allow both types of analysis. Specifically, we derive two alternative spatial unrepresentativeness of legislatures measures: one that compares legislators' birthplace distribution to the population distribution just before their election (we use 2005 as benchmark year), and one that compares legislators' birthplace distribution to the population distribution in the mean legislator birth year.[10] The distribution of population in 2005 may be different from the distribution of population in the mean legislative birth year (and thus the two measures could yield different results) if there are substantial population shifts over time due to e.g. urbanization.

Our data source for population distributions is the gridded population data from the latest

[9] The exclusion of foreign-born legislators is particularly significant for countries like Israel (68% valid entries) and Australia (88% valid entries). In four cases (Argentina, Colombia, Luxembourg, Timor-Leste) we have 2-5 more legislators than the assembly size, so that the share of valid entry is slightly above 100%. This is because we were unable to identify and exclude 'substitutes', who took their seats over the year in which the GLP data was collected.

[10] Legislators' birth year were drawn from the same source as their birthplaces (see previous subsection). The mean legislative birth year ranges from 1951 (France) to 1967 (Macedonia).

Figure 1: Valid non-foreign-born legislator birthplaces as share of assembly size

version of the History Dataset of the Global Environment (HYDE 3.2)[11], which includes population estimates for every year between 1861 and 2005 at the level of 5-by-5 arcminute spatial grids (i.e. cells of roughly 10km side at the equator). These have subsequently been assigned to countries via geocoding of their centroids, and aggregated up to 15-arcminute side grids. In the aggregation, we made sure that, for each country, these larger cells add up all the 5-arcminute side grids *whose centroid falls in the country*, so as to minimise information loss or measurement error in cells along borders and coastlines.

4.1.3 Country Data

Finally, we gathered country-level variables capturing cross-country variation in electoral institutions in force in the last election prior to legislator data collection, as well as other socio-political characteristics. For *constituency structure*, we constructed both a categorical variable (single-, multi- and mixed-member systems) and an interval variable measuring the share of legislators elected in multi-member seats, which we use in the cross-country regression alongside a 'mixed-member system' dummy. A dummy variable for *preferential voting* was coded via a qualitative assessment of ballot rules from legislation or secondary sources. The variable takes the value of 1 if (i) voters can express a preference for one or more individual candidates that is functionally different from a party vote, and (ii) the preference vote can practically determine at least in part the allocation of seats,[12] and 0 otherwise. We also introduce in our models a measure of *district magnitude*, to account for the fact that for very large districts a possible source of spatial inequality in representation might be the unequal selection of candidates *between different parts of the same district*. To record this variable, we followed the coding rules in Carey and Hix (2011), and computed *median district magnitude* and *mean district magnitude* variables, calculated excluding from the count constituencies that are either non- or extra-territorial (e.g. ethnic constituencies, Greenland, nationals abroad). We also collected country-level data on *level of democracy* (V-Dem's unified democracy score), *federalism* (using the list of countries in

[11] https://www.pbl.nl/en/publications/new-anthropogenic-land-use-estimates-for-the-holocene-hyde-32

[12] This second criterion excludes, for instance, the case of Norway, where voters can in theory rearrange the ranking of candidates or cross out candidates they do not want elected, but more than 50% of the party voters have to 'move up' or 'cross out' a candidate to alter the party's preferred ranking – which has never happened, making these options entirely symbolic (Aardal, 2007).

	Mean	SD	Min	Max	N
Share multi-member districts	0.758	0.389	0	1	62
Median district magnitude	20.49	44.019	1	250	62
Mean district magnitude	22.927	45.449	1	250	62
Preferential voting	0.419	0.497	0	1	62
Population ('000)	51,989	165,073	319	1,250,288	62
Population (log)	16.20	1.737	12.67	20.95	62
Km^2 Land area	917,435	2,125,164	320	9,147,420	62
Km^2 Land area (log)	11.952	2.030	5.768	16.029	62
GDP per capita (2011 $ PPP)	24,764	22,435.250	1410	105,265	62
GDP per capita (log)	9,658	1.045	7,252	11,564	62
Assembly Size	236.56	171.67	56	650	62
Level of democracy	1.145	0.555	0.160	2.263	62
Federalism	0.226	0.421	0	1	62
Spatial Gini	0.0492	0.027	0.0128	0.0623	60
Constituency structure					
Single-member	-	-	-	-	9 (16.1%)
Multi-member	-	-	-	-	43 (69.3%)
Mixed-member	-	-	-	-	10 (14.5%)

Table 2: Country-level data

Roeder, 2009) and a measure of geographic economic inequality, the *spatial Gini* (population-weighted Gini index of estimated regional GDP per capita, estimated from satellite nighttime light data in Lessmann and Seidel, 2017). Finally, we also collected data on *population*, *land area* and *GDP per capita* from the World Bank's (2010) World Development Indicator catalog. Descriptive statistics for these variables are presented in Table 2.

4.2 Measurement of SURLI

To produce the Spatial Un-Representativeness of Legislatures Index (SURLI) for a country's legislature, we begin with the geocoded location of each MP's birthplace and the proportion of the population in each grid square of the country. After assigning legislators' birthplaces to grid squares, we can express the two distributions (birthplaces and population) in terms of the proportion observed in each grid square. Our objective is to measure the discrepancy between these two distributions in a way that is comparable across countries of greatly differing territorial size and shape. A natural choice for comparing the two distributions is the Earth Mover's Distance (EMD, Rubner, Tomasi and Guibas, 2000), a metric borrowed from computer science and introduced to political science by Lupu, Selios and Warner (2017). Simply put, EMD measures the amount of work (mass times distance) necessary to transform one distribution to another; as Lupu, Selios and Warner (2017) argue, this closely matches our intuitions about when one distribution is close to another. In our case, EMD measures the minimum total amount of travel necessary to move an equal number of citizens to each MP birthplace.

Although EMD should pick up variation in the (un-)representativeness of a legislature due to e.g. the electoral system, in cross-country comparisons it will also reflect other differences between countries that may obscure these patterns. Notably, it will depend on a country's size: if a country consists of just two cities separated by a desert, then (assuming the proportion of MPs born in each city differs to some extent from the proportion of people living there) the EMD is increasing in the distance between the cities; also, if a country consists of a single grid square, its EMD is zero regardless of its political institutions. The EMD will also depend on the size of the legislature relative to the size of the country: generally, the more seats in the legislature the more closely the distribution of MP birthplaces can potentially match the distribution of inhabitants. Clearly an investigation of the effect of electoral institutions on geographical representation using observational data requires addressing these country-specific determinants of the EMD score. As a first line of defense we control for land area, population, and assembly size in the regressions below. To further address these and other sources of heterogeneity, we compute the SURLI for each country as the ratio of the country's actual EMD to the average EMD we obtain for a large number of simulated legislatures that we produce by choosing MPs at random from the population. Thus a SURLI of k for a country means that the country's observed EMD is k times higher than the average EMD across random representative legislatures *for that country*; country i's SURLI will be higher than country j's if country i's EMD is higher *relative to what would be observed by chance* than country j's is.[13] This normalization procedure helps ensure that variation in SURLI tracks variation in how legislatures are constituted rather than variation in e.g. how countries are shaped or how populations are distributed.

Unfortunately, the time to compute EMD increases exponentially with the number of grid squares, so computing SURLI for a large country like the US (with over 14 thousand grid

[13] More formally, let d denote a country's actual EMD, and let $\delta = \{\delta_1, \delta_2, \ldots, \delta_M\}$ denote M counterfactual EMDs assuming a representative legislature. Then SURLI is $d/\overline{\delta}$.

squares) can take weeks. The complexity of computing EMD in two or more dimensions is well known, prompting efforts to develop efficient implementations and approximations (e.g. Cuturi, 2013). We discovered that, at least for our application of the algorithm on square grids, we could obtain a very efficient approximation to the EMD by computing the one-dimensional EMD for each of several rotations of the gridded map (e.g. east to west, northeast to southwest, north to south, northwest to southeast) and averaging those. As we show in section A of the appendix, the resulting estimate correlates very highly with the two-dimensional EMD in actual cases and can be computed dramatically faster. In one dimension, in fact, the EMD between two distributions is known to be equivalent to the computationally cheap procedure of integrating the area between two CDFs (as proven in Cohen and Guibas, 1997, pp. 13–16), which is the method Golder and Stramski (2010) had suggested for comparing distributions.[14]

Thus SURLI is computed in three steps. First, for each country we measure the spatial difference between the distribution of the population and the distribution of MP birthplaces (both allocated to squares on a gridded map) by computing the one-dimensional EMD (i.e. CDF discrepancy) in each of four rotations of the map and averaging these. Second, for each country we recompute the same measure but for 500 fictional legislatures where MPs are drawn at random from the population distribution. Third, we compute SURLI as the ratio of the value obtained in the first step to the average value obtained in the second step. Note that SURLI scores can be less than one, indicating that the actual measure of discrepancy between MPs' birthplaces and the population distribution is *smaller* than we would expect if legislators were chosen at random.

[14] Lupu, Selios and Warner (2017), in advocating EMD over Golder and Stramski (2010)'s method, were apparently unaware of the equivalence. Our contribution in section A of the appendix is to show that one can closely approximate a two-dimensional EMD by repeatedly integrating one-dimensional CDF discrepancies.

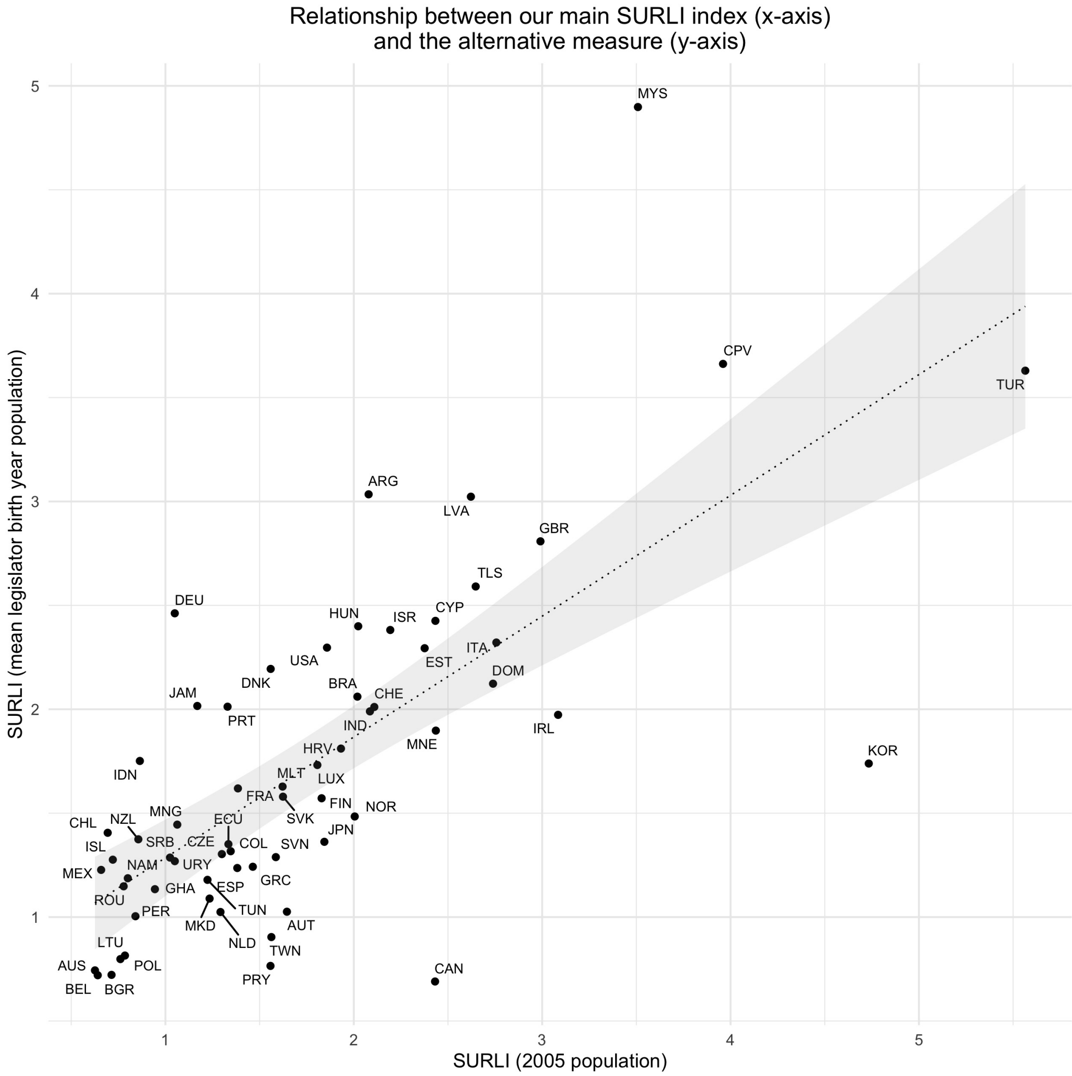

Figure 2: Comparison between SURLI computed against the distribution of the population around the time of the election, and SURLI computed against the distribution of population in the mean birth year of a country's legislators.

As noted above, we compare the distribution of MP birthplaces to two population datasets, one capturing the distribution of the population in 2005 and one capturing the distribution of the population in the year the average MP was born. As shown in figure 2, the correlation between the two sets of scores is quite high (Pearson's $r = 0.71$), though there are substantial differences for some countries (particularly those with significant internal migration due to urbanization or, in the case of Germany, reunification). The correlation between land area and the main measure of SURLI is -0.02, suggesting that our method does appear to net out differences in country size, as desired.

Note that SURLI is a measure of *collective* rather than *dyadic* representation (Weissberg, 1978): it compares the geographic distribution of MP birthplaces to the geographic distribution of population, rather than asking whether e.g. each MP was born in the area he/she represents (Pedersen, Kjaer and Eliassen, 2007). A collective measure of representation is more appropriate for our purposes in part because it can be applied to systems (like Israel and the Netherlands) where MPs do not represent specific districts. Dyadic geographical representation is doubtless important, however, and we will examine it in the within-country analysis below.

4.3 Results and Discussion

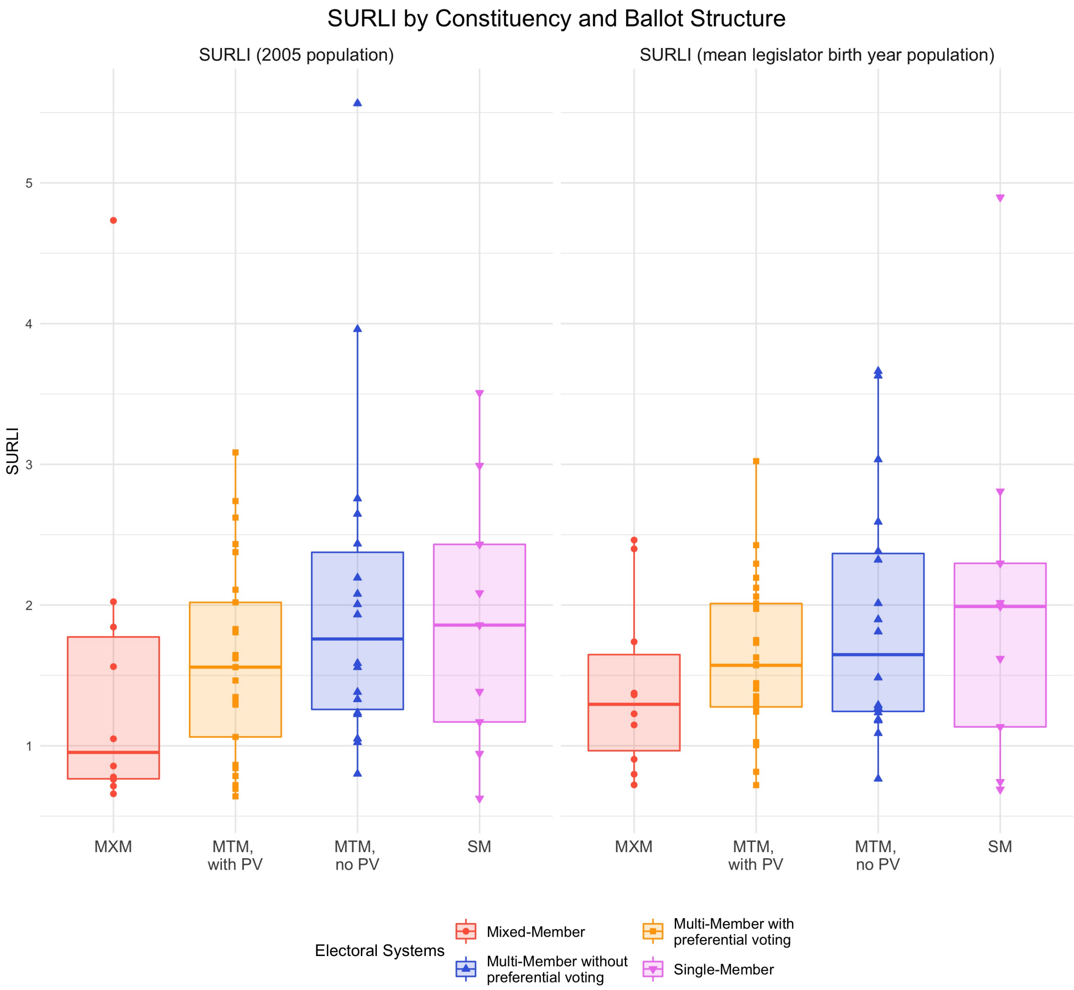

Figure 3: SURLI scores by electoral systems. SM = single-member, MTM = multi-member, MXM = mixed-member, PV = preferential voting. The only MXM country in our sample with PV in the MTM tier (Lithuania) was grouped with MXM for illustrative purposes.

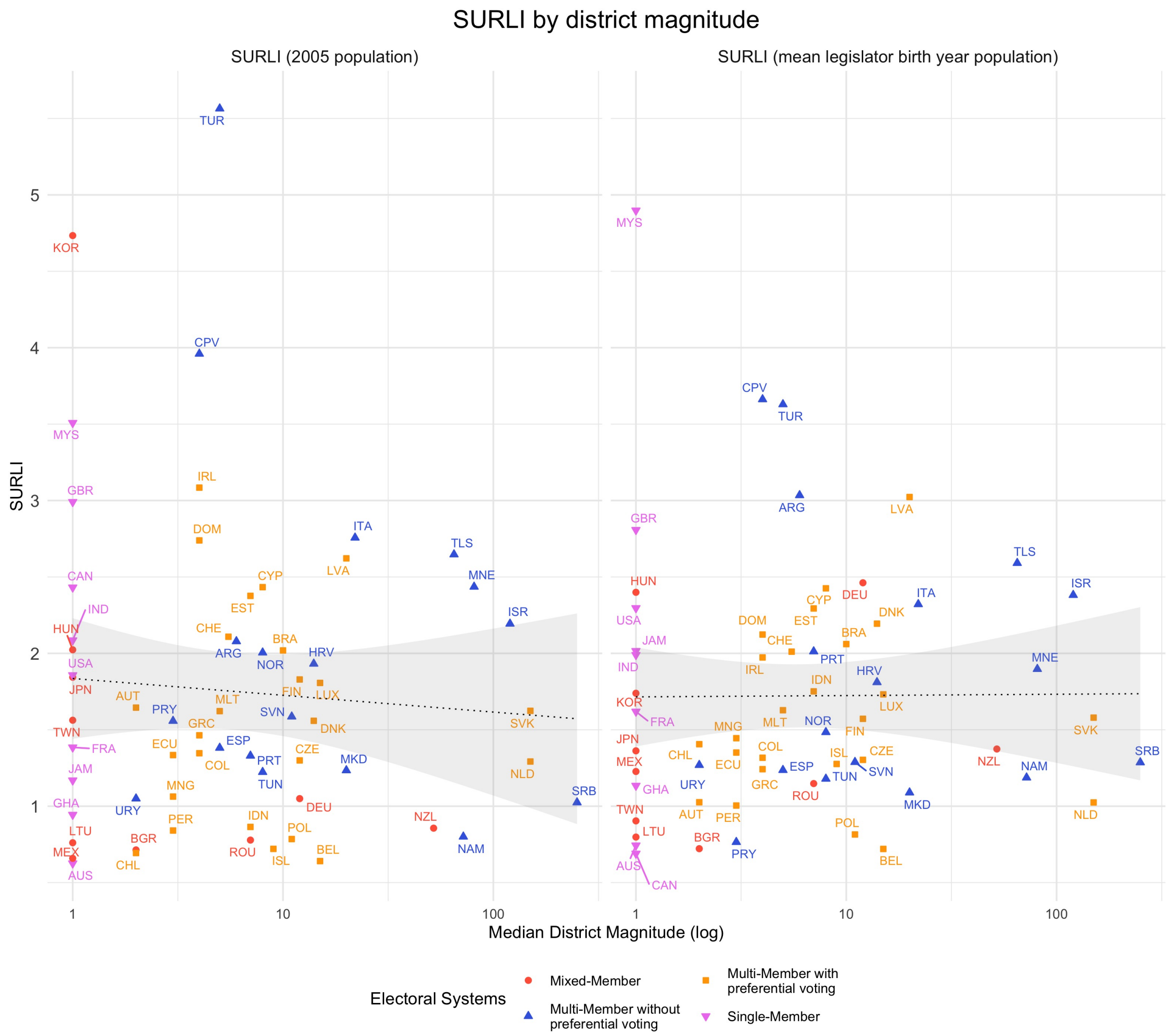

Figure 4: SURLI scores by median district magnitude.

Having derived the spatial unrepresentativeness of legislatures index (SURLI), we can now proceed to investigate its relationship with electoral institutions. Figure 3 shows the distribution of *SURLI (2005 population)* and *SURLI (mean legislator birth year population)* across four major families of electoral systems, defined by their constituency and ballot structures. For both versions of SURLI, the median value in mixed-member systems (MXM) is the lowest, followed by multi-member (MTM) systems with preferential voting (PV). In all systems and for both measures, the median SURLI score is between around 1 (indicating the legislature is about as unrepresentative as we would expect if we drew MPs at random) and 2 (indicating that it is twice as unrepresentative). Single-member district systems (SM) fare poorly relative to multi-member district systems (MTM). Conversely, the scatterplots in Figure 4 show no discernible relationship between SURLI and district magnitude for either SURLI measure.

Table 3 show the results of OLS regression models where our two SURLI measures are regressed on electoral system characteristics as well as demographic and institutional variables. In models 1 and 3, we characterize constituency structure using a three-factor categorical variable; in models 2 and 4, we employ a continuous variable for the share of legislators elected via MTM districts alongside a dummy for mixed-member systems. (This dummy effectively captures the 'additional' effect of mixed-member relative to the predicted value of SURLI if these systems simply functioned as hybrids of single- and multi-member systems.) To capture other potentially relevant features of electoral systems, we include an indicator for preferential voting and a measure of median district magnitude (both described above). We adjust for assembly size and several country features described above.

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean MP birth year)	
	(1)	(2)	(3)	(4)
Constituency Structure 1[a]				
Multi-Member	0.99^{**} (0.41)		0.57^{*} (0.34)	
Single-Member	0.55 (0.46)		0.86^{**} (0.38)	
Constituency Structure 2				
Share Multi-Member		0.22 (0.48)		−0.26 (0.40)
Mixed-Member		-0.77^{**} (0.37)		-0.73^{**} (0.30)
Preferential Voting	-0.54^{*} (0.30)	−0.48 (0.30)	−0.19 (0.24)	−0.20 (0.24)
Median Dist. Mag. (log)	-0.18^{*} (0.11)	−0.16 (0.11)	−0.03 (0.09)	−0.03 (0.09)
Assembly Size	0.002 (0.001)	0.002 (0.001)	0.002^{**} (0.001)	0.002^{**} (0.001)
Population (log)	−0.03 (0.16)	−0.04 (0.16)	−0.14 (0.13)	−0.14 (0.13)
Land Area (log)	−0.15 (0.09)	−0.15 (0.09)	−0.08 (0.08)	−0.08 (0.08)
GDP p.c. (log)	0.32 (0.20)	0.33 (0.20)	0.16 (0.17)	0.16 (0.17)
Democracy Score	−0.57 (0.39)	−0.61 (0.39)	−0.53 (0.32)	−0.52 (0.32)
Constant	1.11 (2.48)	1.80 (2.53)	3.08 (2.04)	4.01^{*} (2.07)
Observations	62	62	62	62
R^2	0.24	0.23	0.23	0.23
Adjusted R^2	0.11	0.10	0.10	0.10
Residual Std. Error (df = 52)	0.93	0.93	0.77	0.77
F Statistic (df = 9; 52)	1.81^{*}	1.73	1.75	1.75

[*a*]: reference category: Mixed-member; *p<0.1; **p<0.05; ***p<0.01

Table 3

The results in Table 3 indicate that, even after including control variables, legislatures tend to be less geographically unrepresentative in mixed-member systems than elsewhere. Models 1 and 3 indicate that SURLI in MXM systems is on average between .5 and 1 points lower than in SM or MTM systems (depending on the SURLI measure), after adjusting for median district magnitude and other factors. Models 2 and 4 indicate that SURLI in mixed-member systems is around .75 lower than in other systems, net of the share of legislators elected via MTM districts and adjusting for other characteristics. The magnitude of the implied differences in predicted SURLI between MXM systems and others is consistent with the unadjusted differences in Figure 3. The findings for *preferential voting* are less clear-cut: the difference is in the predicted direction in all models – i.e. lower SURLI for systems with preferential voting – but it only reaches significance at $p < 0.1$ in model 1. Similarly, *median district magnitude* is negatively related to SURLI in all models but only significant at the .1 level in the first.[15] Notably, in the cross-country analysis we do not find consistent evidence that single-member district systems have more geographically representative legislatures than multi-member district systems. Whatever the advantages of SM constituencies for maintaining connections between MPs and localities, SM systems do not seem to engender more equal access to political office for people born in different parts of the country.

5 Within-country analysis

5.1 Electoral system change and geographic representation: the case of Italy

To complement the cross-country analysis, we present a case study where we compute indicators of geographic representativeness for legislators serving in the Italian Chamber of Deputies in the eleven elections between 1983 and 2022. Over this period of time, Italy experienced three major instances of electoral system change: in 1993, the open-list PR system adopted in 1946 was abandoned in favour of a mixed-member majoritarian formula with a closed-list PR tier; in 2005, it switched to a closed-list PR system with a majority bonus; finally, in 2017, the country moved back to a mixed-member majoritarian system, again with a closed-list PR tier.[16] Table

[15] In section C of the appendix, we present alternative specifications of the models where *federalism* and *spatial Gini* are substituted to *democracy score*, and *mean district magnitude* is employed in lieu of the median. Further robustness checks control for *presidentialism*, substitute *assembly size* to the logged population variable, substitute *number of district* to *mean district magnitude*, introduce a $PV \times$ logged district magnitude term (Carey and Shugart, 1995), and control for *residency requirements* as recorded by Massicotte, Blais and Yoshinaka (2004). The substantive interpretation of the main coefficients of interest is unchanged in each case.

[16] Technically, there were *four* major electoral reforms, as the 2005 law was struck down by the Constitutional Court in 2013, and replaced in 2015 by an Open List PR system with majority bonus. However, this system was never employed in an election, after it was also repealed on grounds of unconstitutionality in 2017. It is also worth noting that in 2020 a further electoral reform reduced the size of the assembly from 630 to 400 members.

4 presents further information on the four institutional set-ups and categorizes them according to constituency structure and preferential voting.

Table 4

Italy's Electoral Systems

	–1993	1993–2005	2005–2015	2017–
Description	Open List PR	MXM Majoritarian	Closed List PR	MXM Majoritarian
Const. Structure	Multi-member	Mixed-Member	Multi-member	Mixed-Member
Pref. Voting	Yes	No	No	No
SM Districts	–	475	–	$232 \rightarrow 147^a$
MTM Districts[b]	32	26	26	$63 \rightarrow 49^a$
% MTM seats	100%	25%	100%	61%
Elections	1983, 1987, 1992	1994, 1996, 2001	2006, 2011, 2013	2018, 2022

Notes: (*a*) the number of SM and MTM districts was reduced following the 2020 Constitutional referendum; (*b*) the count of MTM districts excludes those reserved for Italians resident abroad (introduced in 2005), and includes one single-member district (Aosta), suppressed under MXM.

These instances of institutional reform present us with the opportunity to compare local representation under different institutional set-ups within a single country, holding fixed the factors that cause different countries to choose different electoral systems. Comparisons before and after reforms were instituted do not, of course, perfectly isolate the effect of electoral system reform: on the one hand, other factors changed along with the electoral system (as in 1993, when there was a change in the party system at the same time), raising concerns about confounding, compound treatment, and incidental time trends; on the other, elite selection practices may not change immediately, making it difficult to detect the effect of a short-lived reform. Nonetheless, the institutional variation we observe in Italy can at least allow us to evaluate the *plausibility* of two building blocks of the theory: the role of the SM tier of MXM systems, which we argue tends to favor geographic representation, and that of preferential voting, which in the cross-country analysis emerges as a weak correlate of SURLI but in a direction consistent with the theory. In particular, we expect to find support for these theoretical implications:

1. Legislatures elected via mixed-member system (1993–2005 and post-2017) and via open-list PR (pre-1993) can be expected to be overall more spatially representative than those elected under closed-list PR (2005–2015).

2. Within mixed-member systems, we expect the subset of legislators elected in the SM tier

to be more geographically representative than that of legislators elected in the MTM tier.

Drawing on Italian Chamber of Deputies registry data[17], we compiled information on birthplace and district of election for legislators serving in Italy's Lower House between the ninth (1983–1987) and the nineteenth legislative terms (2022–). The dataset was then reduced to MPs who (i) were in Parliament at the start of the term (thus excluding substitutes) and (ii) were elected to represent Italy's national territory (thus excluding members elected to represent Italians living abroad since 2005). Moreover, for each election year, we compiled population estimates at the level of 15-arcminute side grids, using population-year estimates in HYDE3.2 for elections prior to 2005 and NASA's Gridded Population of the World (GWP, version 4) for elections after 2005.[18]

Figure 5 shows the geographic (un)representativeness of the Italian parliament, both overall and within tiers when appropriate, according to three measures. The top panel shows the share of 'parachuters' (Pedersen, Kjaer and Eliassen, 2007), defined here as MPs who were born outside of the region in which their electoral district is located.[19] While the share of parachuters could not be computed for countries without electoral districts and would not be comparable across countries with different definitions of 'region,' it is an intuitive measure of (un)representativeness for this single-country case study, and helps establish comparability with the analysis of the UK and Germany below. Consistent with expectations, the plot shows that under MTM the legislature was more representative (lower share of parachuters) with PV than without (pre-1993 vs. 2005-2017); also, under MXM the SM tier had a lower share of parachuters (in all parliaments) than the PR tier, which is consistent with the idea that the SM tier helps make MXM systems more geographically representative. The evidence appears more mixed about the comparison of MXM and MTM systems: the post-2017 MXM system had a lower share of parachuters than the 2005-2017 MTM system, which in turn had a similar share of parachuters to the 1993-2005 MXM system. When we average the scores for parliaments within each electoral system/tier in Table 5, we see that all three comparisons are in the expected

[17] http://data.camera.it/data/en/datasets/

[18] GPW provides population estimates at discrete five-year intervals (2005, 2010, 2015, 2020): for elections taking place in the intervening years, we used gridded population data for last year prior to the election. GPW data come from https://sedac.ciesin.columbia.edu/data/collection/gpw-v4

[19] We use Italy's 20 regions, an administrative rather than electoral unit, as the benchmark for localness because electoral districts do not lie across region boundaries in any of the systems we consider.

direction.

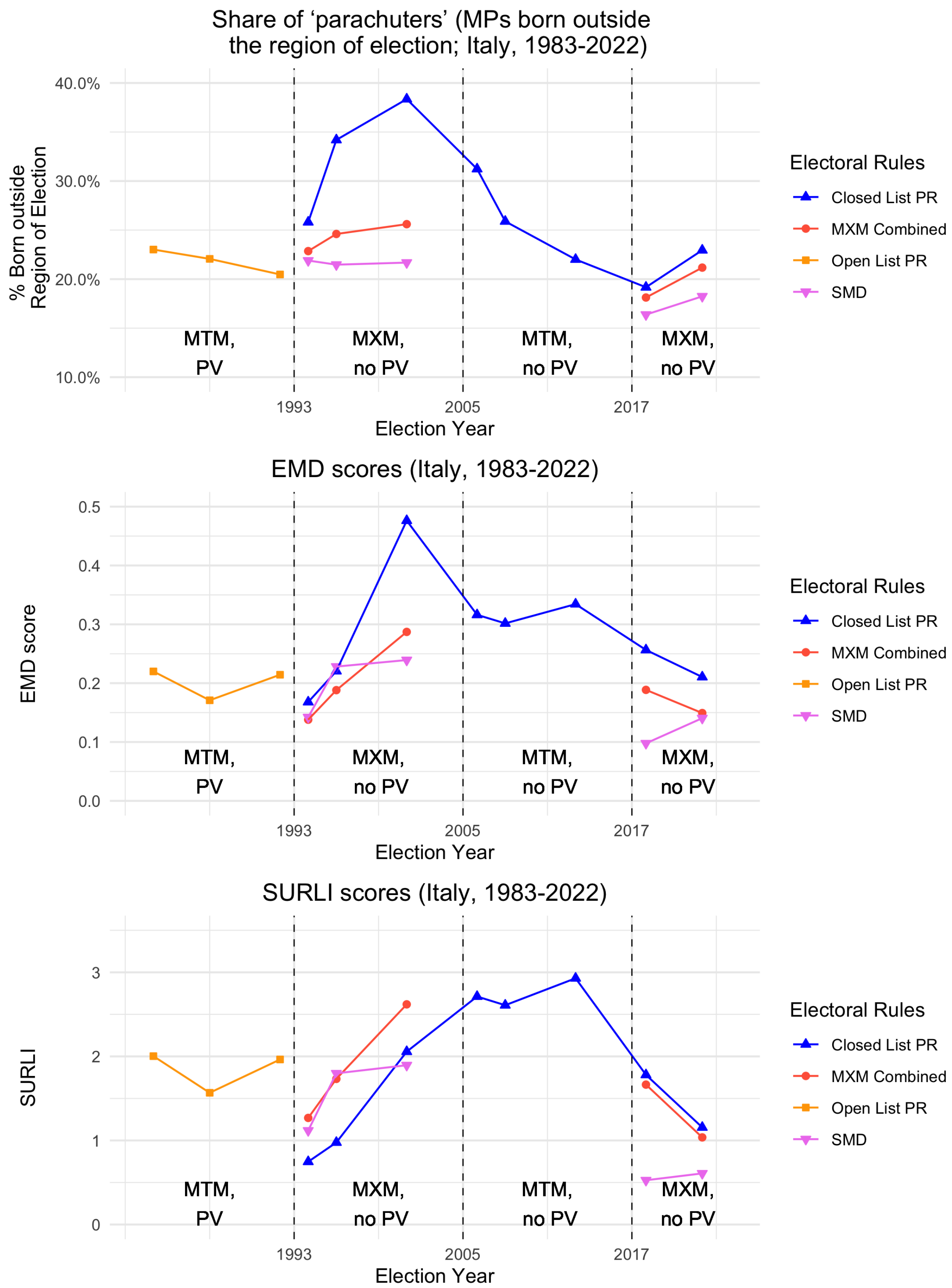

Figure 5: Indicators of geographical representativeness of legislators across election and MXM tiers, Italy. Dotted lines mark the years of major electoral system change.

The second panel shows EMD scores. These results offer solid support for our hypotheses: under MTM, the PV system more clearly has a lower EMD (pre-1993 vs 2005-2017); in both MXM periods, the SMD tier tends to have a lower EMD than the PR tier; and in each of the MXM the legislature is more geographically representative than in the MTM period with no PV (2005-2017). As above, the system averages in Table 5 are consistent with the theory.

For comparison with the cross-country analysis, the third panel shows SURLI scores. The results are broadly similar to the above panels, with one notable difference: the closed list PR tier appears somewhat more representative than the SM tier in the 1993-2005 period, while the relationship was reversed in the other two plots. The reason is that the PR tier had only 155 MPs (compared to 475 in the SM tier); the average EMD of the simulated legislatures for the PR tier, which is the denominator of SURLI, is substantially higher (because the best case for the smaller tier is less representative than the best case for the larger one, and randomly highly unrepresentative parliaments are more likely for the smaller tier too). This adjustment for assembly size is a desirable feature in our cross-national comparisons, but when focusing on a single country either the share of parachuters or the raw EMD may be a clearer indicator of representation. Even so, when averaging within systems/tiers in Table 5 all of the differences are in the expected direction.

Table 5: Mean values of indicators of geographical representativeness.

Electoral System or Tier	Mean Share of 'Parachuters'	Mean EMD	Mean SURLI
'Pure' Closed List PR	0.264	0.317	2.750
'Pure' Open List PR	0.219	0.202	1.845
Mixed-Member, *wherein*	0.226	0.190	1.664
Closed List PR Tier	0.257	0.266	1.343
SMD Tier	0.207	0.170	1.189

5.2 SM district and local representation: UK and Germany compared

The cross-country analysis suggests that mixed-member systems are not only superior to multi-member districts on our measure of spatial representativeness, which is in line with our theoretical expectations; *but they also seem to outperform SM districts.* In this section, we further investigate what makes mixed-member systems more geographically representative. In Section

3 we argued that contamination effects in MXM systems could lead to better local representation in the nominal tier of these systems than in 'pure' single-member systems; essentially, this is because parties in mixed-member systems expect to gain in the multi-member tier by fielding attractive candidates in the nominal tier, which means that more candidates are local (even in safe seats) and fewer seats are safe. To test this argument, in this section we focus on the district level, asking whether each district's MP is a 'parachuter' or local-born, and how this relates to competitiveness differently in single-member and mixed-member systems.[20]

For reasons of data availability, we select two countries – Britain and Germany – as examples of, respectively, a single-member district plurality and a compensatory mixed-member system. The analysis is restricted to Germany's single-member tier. In sum,

1. We expect German single-member district elections to be more competitive than British single-member district elections, because contamination effects induce entry.

2. Compared to British MPs, we expect a smaller proportion of German MPs elected from the nominal tier to be 'parachuters', for the reasons stated above.; in other words, a greater proportion of German MPs should be local to the seat they represent.

3. In the UK, we expect the probability of a parachuter being elected to be higher in safer seats. We expect this to be less the case in the German nominal tier due to contamination effects: a party that expects to win easily may still field a local candidate to boost its results in the multi-member tier.

Given the many ways in which the UK and Germany differ politically, one should not expect a comparison of the two cases to produce conclusive evidence for or against any theory. However, differences consistent with the above expectations would tend to corroborate our interpretation of the broader patterns we find.

We created for each country a dataset that combines biographical information on legislators, district-level data on parties' electoral performance, and spatial data from constituency bound-

[20] We cannot use "born in district" or "born outside district" in our cross-country analysis because district structures differ greatly across countries and electoral systems. (For example, all native Dutch and Israeli MPs are "born in district".) "Born in district" and SURLI measure geographic representation differently. The calculation of SURLI does not consider whether MPs represent the place they were born; conversely, "born in district" does not give any credit for being born close to a district.

ary digital vector files. For both countries, our primary source for MPs' data is the `legislatoR` database (Göbel and Munzert, 2022), which includes – among other information – legislator birthplaces, party affiliation, constituency and electoral tier. We selected British and German single-member district MPs elected in six recent parliamentary elections (respectively, 2001-2019 and 1998-2017), for a total of 3,971 British and 1,823 German legislator-session entries.[21] We complemented the birthplace data in the dataset with further research and geocoded the locations found, yielding virtually complete coverage of the sample for this variable (see the first row of tables 6 and 7). Using constituency names and codes, we linked each entry to party shares of the vote *in the previous election* (this approximates parties' priors in the candidate selection stage). To account for redistricting, for the UK sample we combined data from the House of Commons library with notional seat shares estimated by Rallings and Thrasher;[22] for Germany, we used both 'real' and notional district-level results published for each election by the *Bundeswahlleiter* (German federal electoral commission). Constituencies were then linked to geocoded vector polygon data in shapefiles obtained from the *UK Data Service* and the *Bundeswahlleiter*.

	United Kingdom						
Election year	2001	2005	2010	2015	2017	2019	overall
Share valid birthplaces	0.94	0.99	0.98	0.98	0.98	0.97	0.97
Mean margin in last election	0.24	0.23	0.19	0.18	0.24	0.24	0.22
Median margin in last election	0.24	0.23	0.19	0.18	0.24	0.24	0.22
Share Safe seats (> 10% margin)	0.76	0.79	0.74	0.69	0.81	0.74	0.76
Share Ultrasafe seats (> 20% margin)	0.51	0.51	0.43	0.43	0.59	0.57	0.51
Med. distance MP birthplace-seat (km)	93.57	100.20	89.21	73.09	72.00	57.74	79.50
Share of 'parachuters'	0.75	0.76	0.75	0.72	0.71	0.68	0.73

Table 6: Descriptive statistics, UK MPs sample

We address the first two hypotheses – concerning district competitiveness and extent of local representation – via simple descriptive analysis. From real or notional district-level electoral data, we computed a *margin in last election* variable, as the difference between the share of the vote for the largest party in the previous election and the share of its closest competitor.

[21] The British sample also includes MPs elected via by-elections held between 1997 and 2019.

[22] In the period under consideration, English and Welsh constituency boundaries changed between the 2005 and 2010 elections, while Scottish and Northern Irish seats were redistricted between 2001 and 2005. We could not find notional estimates of party shares in the 2001 election for Northern Ireland seats as configured in 2005. Data for 2005 notional results are available from Pippa Norris's personal website at https://www.pippanorris.com/data; we are thankful to Lewis Baston for providing data for 2001 notional results for Scotland.

	Germany (single-member district tier)						
Election year	1998	2002	2005	2009	2013	2017	overall
Share valid birthplaces	0.99	0.99	0.99	1.00	1.00	1.00	1.00
Mean margin in last election	0.14	0.13	0.15	0.14	0.14	0.18	0.14
Median margin in last election	0.14	0.13	0.15	0.14	0.14	0.18	0.14
Share Safe seats (> 10% margin)	0.55	0.53	0.59	0.57	0.54	0.68	0.57
Share Ultrasafe seats (> 20% margin)	0.27	0.22	0.27	0.23	0.26	0.39	0.27
Med. distance MP birthplace-seat (km)	29.48	26.16	24.83	20.68	18.54	18.88	21.76
Share of 'parachuters'	0.38	0.29	0.30	0.27	0.22	0.26	0.29

Table 7: Descriptive statistics, German single-member district MPs sample

Furthermore, we used the digital vector data to compute, for each legislator, the seat in the current election that includes the legislator's birthplace. Additionally, we computed the geodesic distance between the legislator's birthplace and the centroid of the seat she represents. Finally, we combined these two pieces of information to create a binary *parachuter* variable that takes the value of 1 if both these conditions are satisfied: (i) the legislator's birthplace falls outside the area of the seat she represents, or (ii) the legislator is born farther than 20km from the centroid of the seat she represents. This double-safe coding rule is meant to minimise measurement errors in districts of varying size. For instance, using only the first criterion, any legislator born in London would be coded as being from the central seat of 'Cities of London and Westminster' (and a parachuter to any other London seat). But obviously given that information they could be local to any other London seat. Equally, using only the second criterion an MP born in Dumfries – the major settlement in the 4,000 km^2 rural Scottish constituency of Dumfries and Galloway – would incorrectly be coded as a parachuter to the seat they were born in, because the town is not close enough to the constituency's centroid.

The measures of district competitiveness and local representation we provide in Tables 6 and 7 are consistent with our expectations: UK constituencies are less competitive on average than German SM districts, and British MPs are far more likely to be born outside of their constituencies than German SM district legislators. The most competitive election in the UK in terms of mean and median previous margin (2015) is less competitive than the least competitive election in German SM district seats (2017). Over three quarters of UK constituencies are 'safe' (the margin is larger than 10%) and over half are 'ultra-safe' (the margin is larger than 20%), against 57% and 27% in German single-member districts. As far as local representation is concerned, the contrast is equally stark. Under the aforementioned definition of being a 'parachuter', only 29% of German single-member district legislators are born outside their constituency, against 73% of British MPs. This does not appear to be simply an artifact of German constituencies being larger: the median distance between an MP's birthplace and the centroid of the constituency she represents is 22km in Germany and 79km in the UK.[23]

	Dependent variable:	
	P(new MP is a 'parachuter')	
	Model 1	Model 2
Party margin in previous election	0.90** (0.44)	1.10** (0.49)
Constituency land area	0.0001 (0.0001)	0.0002* (0.0001)
Party[a]		
Labour	−1.20*** (0.20)	−2.47*** (0.82)
Lib Dem	−0.35 (0.35)	−2.06** (0.96)
Other	−1.28*** (0.38)	−2.24** (1.04)
SNP	−0.74** (0.31)	−1.96 (1.38)
Election[b]		
2005	0.03 (0.33)	−0.87 (0.83)
2010	−0.21 (0.30)	−1.13 (0.76)
2015	−0.66** (0.31)	−1.78** (0.78)
2017	−0.55 (0.34)	−1.82** (0.83)
2019	−0.81*** (0.31)	−1.96** (0.76)
By-election	−0.19 (0.66)	−1.57 (1.37)
Constant	1.53*** (0.28)	2.54*** (0.73)
Party × Election Interaction	No	Yes
Observations	864	864
Log Likelihood	−511.19	−497.66
Akaike Inf. Crit.	1,048.38	1,065.32

[*a*] = ref. cat. Conservative, [*b*] = ref. cat. 2001
*p<0.1; **p<0.05; ***p<0.01

Table 8: Binomial logistic models. The estimates capture the variables' effect on the probability that a newly elected British MP is born outside the constituency she represents (i.e. is a 'parachuter'). Model 2 includes Party × Election interactions: interaction terms' coefficients not shown for reasons of space.

Next we probe the relationship between seat marginality and parties' incentives to parachute candidates in the two cases. We first restrict the two samples to newly-elected legislators only, in order to have observations that capture outcomes of party and voter choices taken at the

[23]In section D of the appendix, we show that German MPs elected via the SM tier are much less likely than MPs elected via the MTM tier to be born outside the State from which they were elected.

	Dependent variable:	
	P(new MP is a 'parachuter')	
	Model 1	Model 2
Party margin in previous election	−1.24* (0.69)	−1.66** (0.81)
Constituency land area	0.0002** (0.0001)	0.0002* (0.0001)
Party[a]		
Other	−0.39 (0.53)	−13.94 (882.74)
SPD	−0.09 (0.23)	0.07 (0.56)
Election[b]		
2002	−0.50* (0.30)	−0.39 (0.60)
2005	−0.46 (0.34)	−0.27 (0.62)
2009	−0.73** (0.32)	−0.74 (0.57)
2013	−0.89** (0.36)	−0.62 (0.59)
2017	−0.28 (0.34)	0.17 (0.57)
Constant	−0.46 (0.29)	−0.57 (0.54)
Party × Election Interaction	No	Yes
Observations	604	604
Log Likelihood	−365.32	−361.20
Akaike Inf. Crit.	750.64	760.40

[*a*] = ref. cat. CDU/CSU, [*b*] = ref. cat. 1998
*p<0.1; **p<0.05; ***p<0.01

Table 9: Binomial logistic models. The estimates capture the variables' effect on the probability that a newly elected German single-member district MP is born outside the constituency she represents (i.e. is a 'parachuter'). Model 2 includes Party × Election interactions: interaction terms' coefficients not shown for reasons of space.

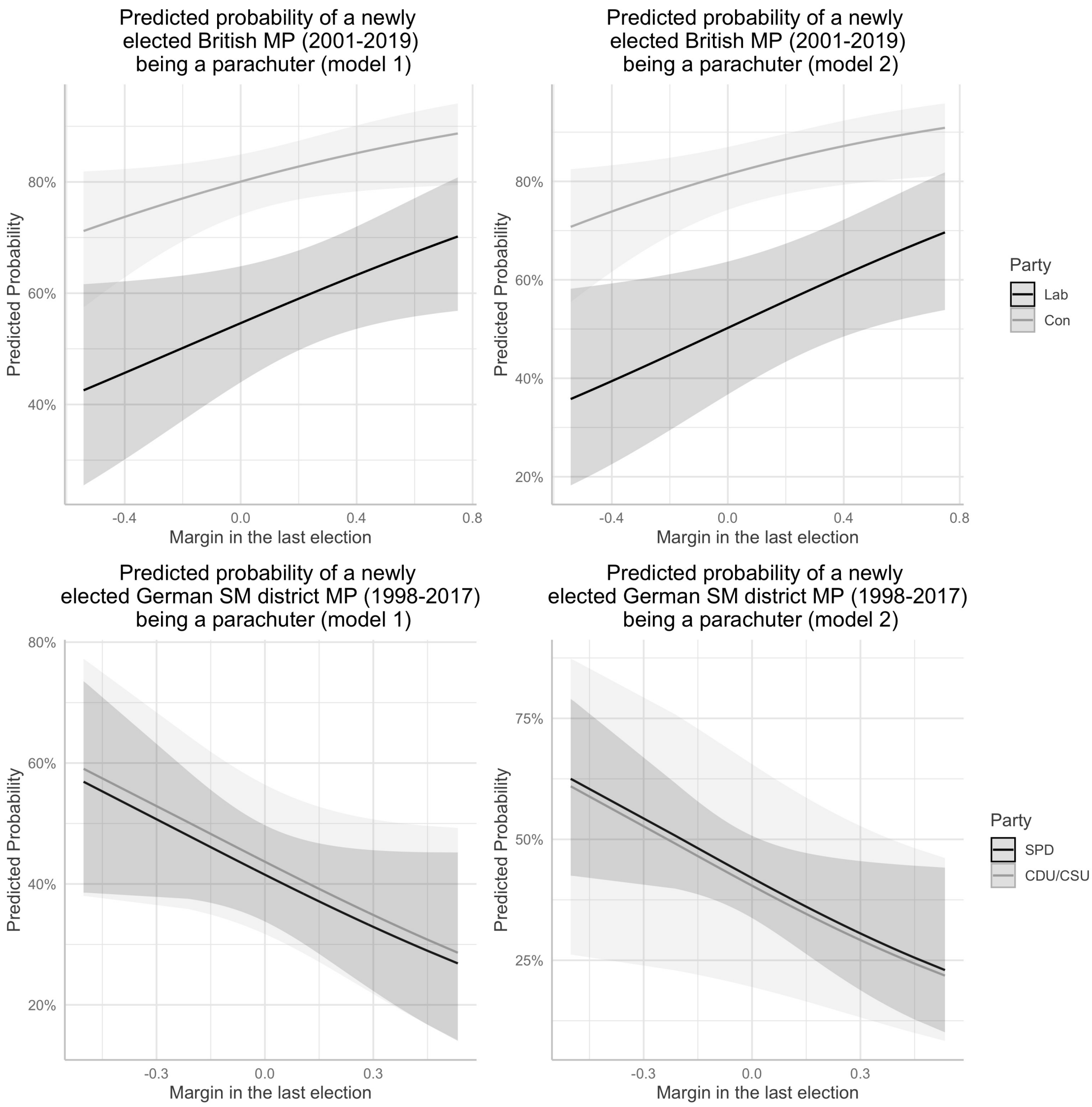

Figure 6: Predicted probability of a parachuter being selected for a SM district conditional on seat safety, major parties (logistic models in Tables 8 and 9).

same time and based on known priors of seat competitiveness.[24] Within these samples, which amount to 864 entries for the UK and 604 for Germany's single-member district tier, we model the binary outcome variable *parachuter* as a function of how well the MP fared in the same seat at the previous election. This *party margin in previous election* regressor is computed as the difference between the vote share of the winning MP's party in the previous election and the

[24]Incumbents may have secured a seat many electoral cycles prior to each individual election, when the calculus of party selection was different: e.g. a seat may have 'become' more or less safe over time. But parties seldom reassess candidate selection for seats in which a legislator intends to run again, demanding her to step down for a candidate they like better if the seat has become safer, or for a candidate with stronger local credentials if the seat has become more competitive.

vote share of the top-ranking competitor. Unlike the absolute measure of marginality discussed before, this variable can take negative values when the legislator's party lost the previous contest (or at least would have, under the current boundaries). As controls, we include party and election dummies as well as a measure of constituency land area (a proxy for urban/rural seat distinction). Moreover, in model 2 we include interactions between party and election dummies, so that comparisons are effectively between safer and less safe MPs from the same party in the same year, as well as additional controls (region, gender and the log of constituency land area) in the tables presented in section E of the appendix.

The logistic regression coefficients for the British and German samples of legislators are shown in tables 8 and 9; the marginal effects of party margin on the dependent variable across model specifications are plotted in Figure 6 for the two major parties in each countries. In the UK sample, we find the expected positive relationship between seat safety and likelihood of a parachuter being elected: MPs elected from safer seats are less likely to be born in the district than those elected from less safe seats, in part because parties use these seats as comfortable destinations for insiders. Strikingly, the relationship is instead *negative* in German single-member districts: MPs elected from safer seats are *more* likely to be born in the district than those elected from less safe seats. This may be because the opportunity to win party-list votes through spillovers is greater in party strongholds, or because potential local candidates are more plentiful in such places.

6 Conclusion

In the title of their influential edited volume, Shugart and Wattenberg (2001) asked whether mixed-member systems offer the 'best of both worlds' relative to single-member districts and proportional representation. From the point of view of descriptive representation of places in parliaments, our analysis suggests that we can answer that question positively. Judging by our new measure, there is not much difference in geographical representativeness between single-member and multi-member district systems, but legislatures elected in mixed-member systems seem to be significantly more geographically representative than both. This finding chimes with our theoretical intuition that, due to contamination effects, the single-member tier of mixed-member systems is more conducive to electing local candidates than either single-member districts in single-member systems or multi-member districts. Alongside a cross-country analysis, we provide additional evidence in this direction by analysing patterns of local representation among Italian legislators elected under different electoral rules, as well as comparing single-member district MPs elected in a MXM (Germany) and in a SM system (Britain). We found that Italian legislatures elected under MXM rules are more representative than those elected under MTM rules without preferential voting; moreover, this seems to be attributable to higher representativeness of MXM systems' nominal tier. Moreover, we observe that a much larger proportion of German MPs were born in their single-member district than British MPs; moreover, safer seats are more likely to be represented by a 'parachuter' in the UK, whereas the opposite is true in Germany.

This study has important limitations. Our cross-country analysis uses a rather coarse system to classify electoral institutions. We mentioned in passing the possible effect of US-style party primaries, but there are other institutional features that we just do not have enough variation in the sample to study comparatively at this stage: different electoral formulae in SM systems, the nature of tier linkage in mixed-member systems, legal electoral thresholds in multi and mixed-member systems etc. An additional limitation, already noted in section 4.1, is that inferring MPs' ties to geographic locales from birthplaces discounts other aspect of a legislator's biography – education, work, length of residence – that may link her to a community. Systematically gathering this information for a large set of countries is an enormous task, but the resulting measure might better characterize MPs' geographical ties. Another direction of research might involve devising a measurement for the *substantive* representation of places rather than their *descriptive* representation.

Nonetheless, we believe that this paper makes valuable contributions in at least two senses. From a methodological point of view, it develops a practical method for measuring the congruence between spatial distributions in a comparable way across polities and can therefore be applied to the study of other spatial inequalities in political outcomes. From a substantive point of view, the analysis has normative implications for electoral system design, providing evidence against the 'constituency linkage' argument according to which SM districts lead to better, more personalised representation of locales: an argument not only made by supporters of existing majoritarian systems (Kelly, 2008) but also often conceded by electoral reformers (Jenkins, 1998; British Columbia Citizens' Assembly on Electoral Reform, 2004). To the extent that having legislators that reflect the geographic diversity of a country can be considered a relevant democratic objective, it emerges that other electoral institutions – mixed-member systems, and possibly preferential voting – may be more effective means to achieve this goal.

Acknowledgements

We are grateful to Christine Sheldon and Esme Lillywhite for excellent research assistance; to Erzen Öncel for her help with the GLP data; to Patricia Calca and Sebastian Koehler for data on Portugal; Jaehee Jung for help with Korean MPs; to participants at the Comparative Research on Political Elites conference (Hertie School, Berlin), the Inequality and Representation workshop (Rothermere American Institute, University of Oxford), University of Manchester, and Syracuse University for helpful feedback; to Christian Lessmann for assistance with spatial inequality data; to Matthew Shugart, Jonne Kamphorst, Ben Ansell, Tarik Abou-Chadi, Spyros Kosmidis and Tom O'Grady for comments.

Funding

This research was partly supported by an ESRC (Grand Union DTP) research training support grant and studentship.

Competing Interests

None.

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Appendix

A Validation of EMD Proxy

This section illustrates our approach to deriving a proxy for two-dimensional Earth Mover's Distance (EMD) measure of discrepancy between two spatial distributions. We begin with two distributions, each characterized by a set of coordinates in two dimensions and associated weights, with each distribution's weights summing to 1. In one dimension, the EMD is equivalent to the integral of the discrepancy between the two cumulative distribution functions (CDFs), and can thus be computed quickly. In more than one dimension, the EMD is computationally costly and thus inconvenient for distributions with many coordinates.

Our proposed proxy computes the EMD in one dimension, then repeats the calculation over several rotations of the data, and finally averages these measurements. Figure 7 below conveys the concept: we sweep through the data in the direction of each arrow, computing the 1-dimensional EMD (equivalently, the integral of CDF discrepancy) in each pass – in the figure, the cases for 3 and 6 rotations are shown – and then average the values of the EMD obtained in each of these passes.

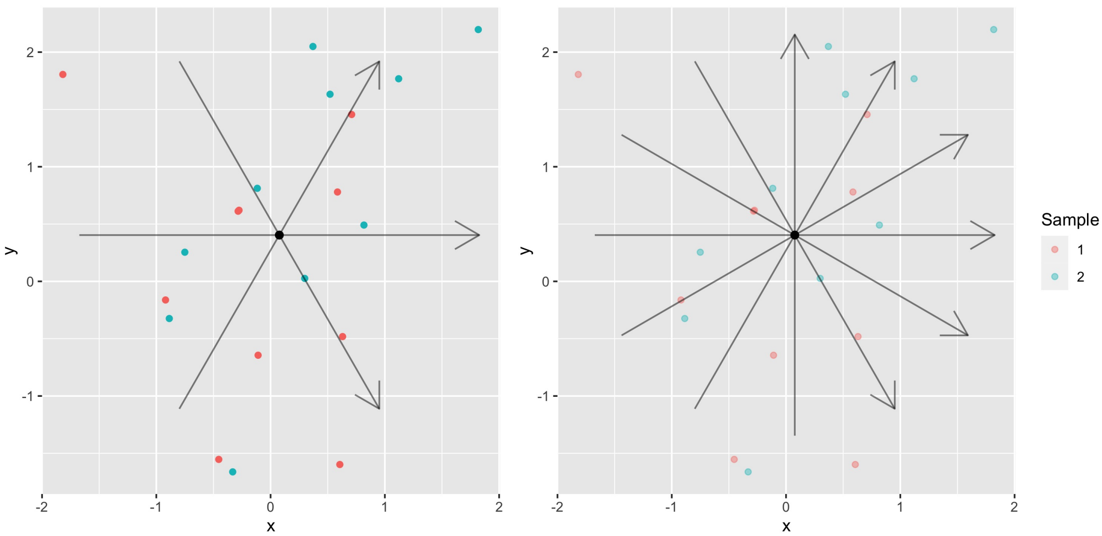


Figure 7

There is no expectation that the two procedures would agree perfectly. For example, suppose to begin with that two distributions are identical; then the 2-dimensional EMD will be zero, as will the 1-dimensional EMD in each rotation, so the two measures will agree. If we then shift one distribution one unit to the east, the EMD will be approximately 1; the 1-dimensional CDF discrepancy will be 1 in the east-west direction, 0 in the north-south direction, and something in between in other directions (so that the mean will be between 0 and 1). The properties of the proposed proxy may require deeper investigation for other uses, but for the purpose of this paper we seek only to show that the proxy agrees closely with the two-dimensional EMD in the data we analyze. To show that it is the case, we compute the EMD and the proposed proxy (with a number of rotations ranging from 3 to 10), and compare the distribution of legislator birthplaces to the distribution of the population (both gridded) in 53 countries (all but the largest 10). The results plotted below show that the two measures agree very closely. In figure 8, we show the scatter plots of the EMD and its proxy for the 53 countries in the restricted sample across different parameters for the number of rotations. Figure 9 shows how the correlation (in red) and the correlation of ranks (in blue) varies with the number of rotations. For this dataset, the correlation of ranks is slightly lower for lower numbers of rotations, but all correlations are well above .95, suggesting the proxy is valid for our purposes across all values tested.

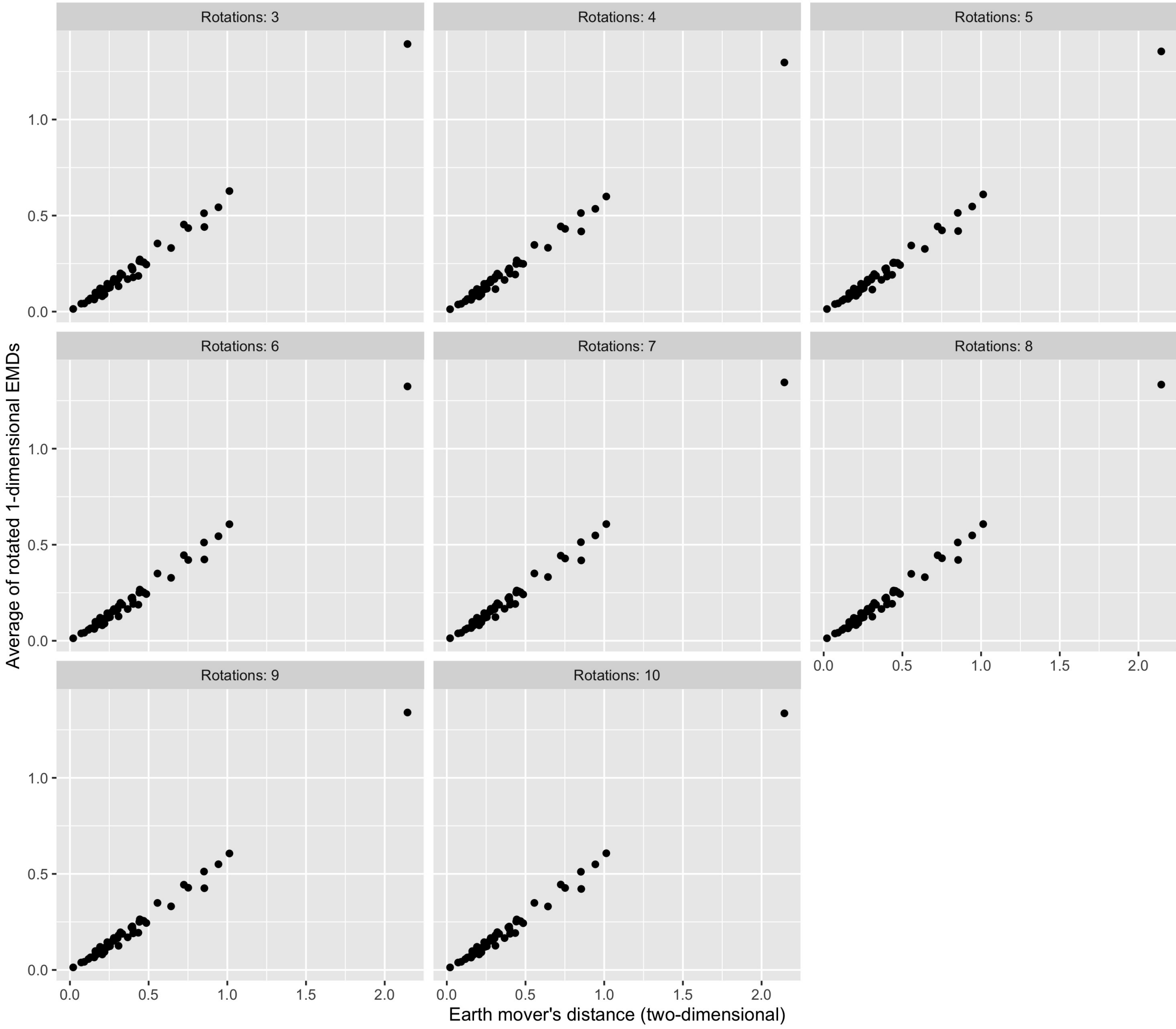
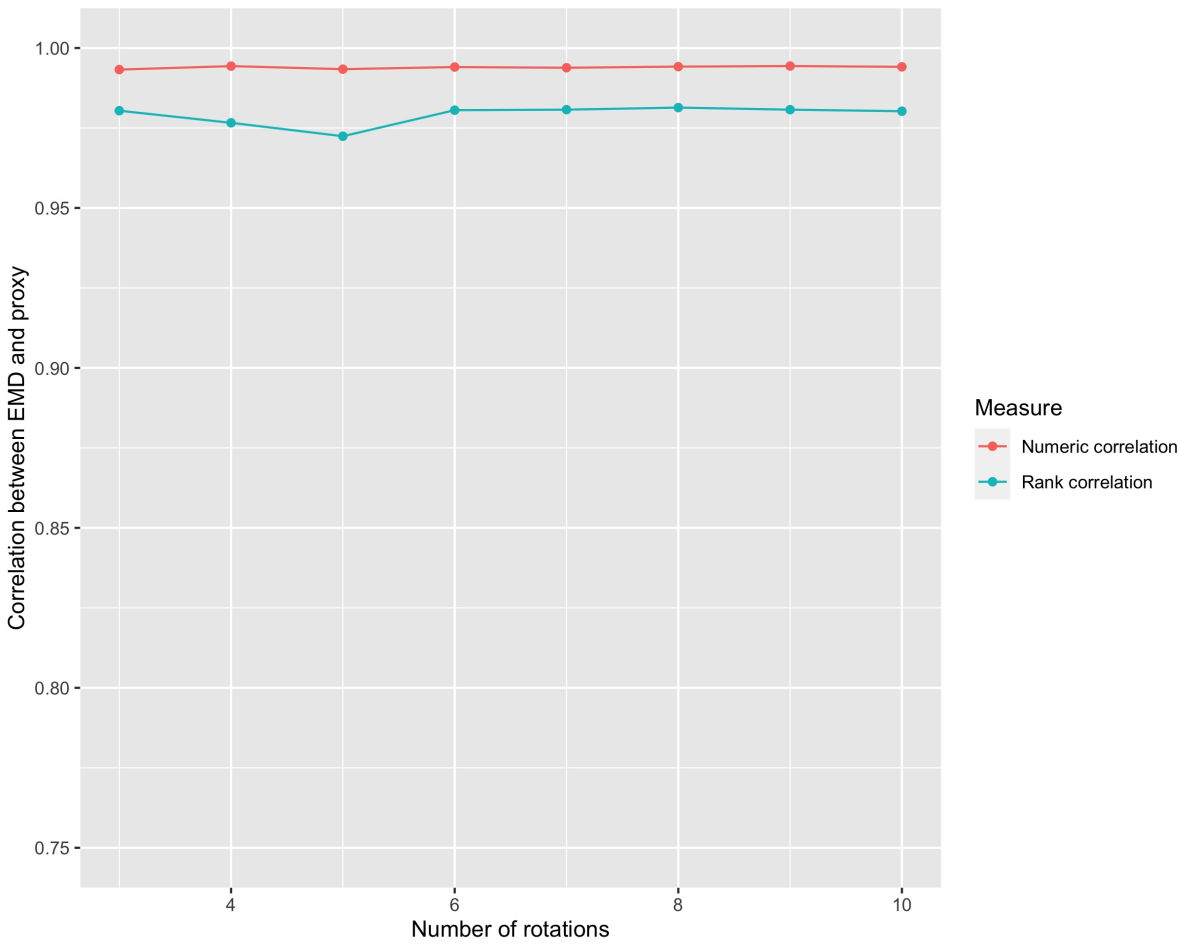


Figure 8



1.00
0.95
0.90
0.85
0.80
0.75
Correlation between EMD and proxy
4
6
8
10
Number of rotations
Measure
Numeric correlation
Rank correlation

Figure 9

B Distribution of SURLI scores by mean district magnitude

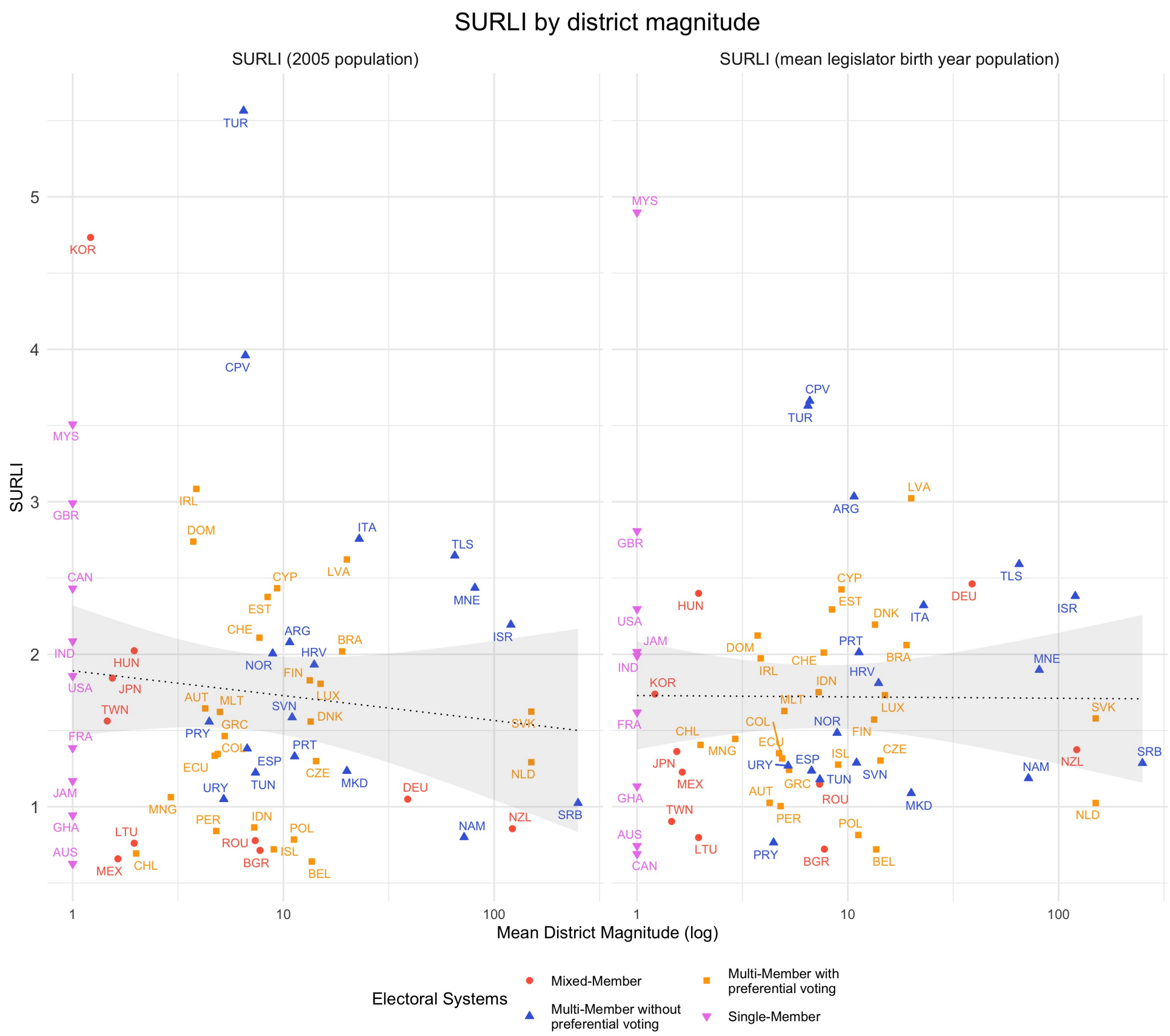


Figure 10: Figure 4 with alternative measurement of the district magnitude variable.

C Robustness Checks (Cross-country analysis)

Table 10: Alternative specifications of model 1 in table 3

	Dependent variable:				
	SURLI (2005 benchmark)				
	(1)	(2)	(3)	(4)	(5)
Multi-Member	1.03** (0.42)	1.03** (0.43)	0.93** (0.40)	0.98** (0.40)	0.98** (0.41)
Single-Member	0.45 (0.46)	0.43 (0.47)	0.40 (0.48)	0.28 (0.48)	0.26 (0.49)
Preferential Voting	−0.60* (0.30)	−0.53* (0.31)	−0.56* (0.30)	−0.62** (0.30)	−0.56* (0.31)
log(median DM)	−0.18 (0.11)	−0.21* (0.12)			
log(mean DM)			−0.20* (0.11)	−0.20* (0.11)	−0.23* (0.12)
log(Population)	0.05 (0.16)	0.04 (0.17)	−0.04 (0.16)	0.04 (0.16)	0.03 (0.17)
log(Land Area)	−0.18* (0.09)	−0.22* (0.12)	−0.15 (0.09)	−0.17* (0.09)	−0.22* (0.12)
log(GDP p.c.)	0.09 (0.12)	0.10 (0.14)	0.31 (0.20)	0.09 (0.12)	0.10 (0.14)
Assembly Size	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)
Federalism	−0.19 (0.36)			−0.15 (0.36)	
Spatial Gini		1.03 (6.86)			0.95 (6.78)
Democracy score			−0.54 (0.39)		
Constant	1.64 (2.60)	2.11 (2.70)	1.32 (2.48)	1.91 (2.61)	2.34 (2.70)
Observations	62	60	62	62	60
R^2	0.21	0.23	0.24	0.22	0.24
Adjusted R^2	0.08	0.09	0.11	0.08	0.10
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 11: Alternative Specifications of model 2 in table 3

	Dependent variable:				
	SURLI (2005 benchmark)				
	(1)	(2)	(3)	(4)	(5)
Share Multi-Member	0.37 (0.48)	0.36 (0.50)	0.34 (0.52)	0.49 (0.51)	0.50 (0.53)
Mixed-Member	−0.73* (0.37)	−0.72* (0.37)	−0.67* (0.36)	−0.62* (0.37)	−0.61 (0.37)
Preferential Voting	−0.54* (0.30)	−0.47 (0.31)	−0.51* (0.30)	−0.57* (0.30)	−0.51 (0.31)
log(median DM)	−0.15 (0.11)	−0.17 (0.11)			
log(mean DM)			−0.18 (0.11)	−0.18 (0.11)	−0.20* (0.12)
log(Population)	0.05 (0.17)	0.05 (0.17)	−0.04 (0.16)	0.04 (0.16)	0.04 (0.17)
log(Land area)	−0.18* (0.09)	−0.24* (0.12)	−0.15 (0.09)	−0.18* (0.09)	−0.23* (0.12)
log(GDP p.c.)	0.09 (0.13)	0.11 (0.14)	0.32 (0.20)	0.09 (0.13)	0.11 (0.14)
Assembly Size	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)
Federalism	−0.21 (0.36)			−0.18 (0.36)	
Spatial Gini		2.02 (6.86)			1.81 (6.81)
Democracy Score			−0.58 (0.39)		
Constant	2.19 (2.67)	2.61 (2.77)	1.79 (2.52)	2.22 (2.66)	2.59 (2.74)
Observations	62	60	62	62	60
R^2	0.20	0.21	0.24	0.21	0.22
Adjusted R^2	0.06	0.07	0.10	0.07	0.08
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 12: Alternative specifications of model 3 in table 3

	Dependent variable:				
	SURLI (mean legislator birth year benchmark)				
	(1)	(2)	(3)	(4)	(5)
Multi-Member	0.57 (0.35)	0.54 (0.35)	0.53 (0.33)	0.55 (0.33)	0.52 (0.33)
Single-Member	0.64* (0.38)	0.82** (0.38)	0.87** (0.40)	0.63 (0.40)	0.83** (0.40)
Preferential Voting	−0.26 (0.25)	−0.16 (0.25)	−0.18 (0.25)	−0.26 (0.25)	−0.15 (0.25)
log(median DM)	−0.03 (0.09)	−0.01 (0.10)			
log(mean DM)			−0.01 (0.09)	−0.02 (0.09)	0.002 (0.10)
log(Population)	−0.12 (0.13)	−0.01 (0.14)	−0.14 (0.13)	−0.12 (0.13)	−0.01 (0.14)
log(Land area)	−0.13* (0.08)	−0.22** (0.10)	−0.08 (0.08)	−0.13 (0.08)	−0.22** (0.10)
log(GDP p.c.)	−0.08 (0.10)	0.02 (0.11)	0.16 (0.17)	−0.09 (0.10)	0.02 (0.11)
Assembly Size	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)
Federalism	0.34 (0.29)			0.35 (0.29)	
Spatial Gini		7.82 (5.60)			8.06 (5.58)
Democracy Score			−0.53 (0.32)		
Constant	5.00** (2.13)	2.97 (2.21)	3.04 (2.05)	5.00** (2.15)	2.90 (2.22)
Observations	62	60	62	62	60
R^2	0.21	0.23	0.23	0.21	0.23
Adjusted R^2	0.08	0.09	0.10	0.08	0.09
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 13: Alternative specifications of model 4 in table 3

	Dependent variable:				
	SURLI (mean legislator birth year benchmark)				
	(1)	(2)	(3)	(4)	(5)
Share MTM	−0.09 (0.39)	−0.25 (0.41)	−0.31 (0.42)	−0.10 (0.42)	−0.29 (0.43)
Mixed-Member	−0.61** (0.30)	−0.70** (0.30)	−0.72** (0.30)	−0.60* (0.30)	−0.69** (0.30)
Preferential Voting	−0.26 (0.25)	−0.16 (0.25)	−0.19 (0.25)	−0.25 (0.25)	−0.15 (0.25)
log(median DM)	−0.02 (0.09)	−0.02 (0.09)			
log(mean DM)			−0.01 (0.09)	−0.02 (0.09)	−0.001 (0.10)
log(Population)	−0.12 (0.13)	−0.02 (0.14)	−0.14 (0.13)	−0.12 (0.13)	−0.02 (0.14)
log(Land area)	−0.13 (0.08)	−0.21** (0.10)	−0.08 (0.08)	−0.13 (0.08)	−0.21** (0.10)
log(GDP p.c.)	−0.09 (0.10)	0.02 (0.11)	0.16 (0.17)	−0.09 (0.10)	0.02 (0.11)
Assembly Size	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)
Federalism	0.35 (0.29)			0.35 (0.29)	
Spatial Gini		7.66 (5.56)			7.93 (5.55)
Democracy Score			−0.52 (0.32)		
Constant	5.70** (2.17)	3.87* (2.24)	3.97* (2.07)	5.69** (2.17)	3.80* (2.24)
Observations	62	60	62	62	60
R^2	0.21	0.23	0.23	0.21	0.23
Adjusted R^2	0.08	0.09	0.10	0.08	0.09
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 14: Main model, excludes micro-countries (no. grids $\leq$ 20)

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean legislator birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	0.82^{*} (0.41)		0.41 (0.33)	
Single-Member	0.68 (0.46)		0.95^{**} (0.37)	
Share MTM		−0.03 (0.48)		−0.47 (0.39)
Mixed-Member		-0.77^{**} (0.36)		-0.71^{**} (0.29)
Preferential Voting	−0.35 (0.30)	−0.29 (0.30)	−0.04 (0.25)	−0.05 (0.25)
log(median DM)	−0.13 (0.11)	−0.11 (0.11)	0.02 (0.09)	0.01 (0.09)
log(Population)	−0.02 (0.16)	−0.03 (0.16)	−0.12 (0.13)	−0.13 (0.13)
log(Land area)	−0.12 (0.10)	−0.12 (0.10)	−0.04 (0.08)	−0.04 (0.08)
log(GDP p.c.)	0.53^{**} (0.23)	0.55^{**} (0.23)	0.36^{*} (0.18)	0.34^{*} (0.18)
Assembly Size	0.002 (0.001)	0.002 (0.001)	0.002^{*} (0.001)	0.002^{**} (0.001)
Democracy Score	-0.91^{**} (0.42)	-0.96^{**} (0.42)	-0.85^{**} (0.34)	-0.82^{**} (0.34)
Constant	−1.16 (2.74)	−0.39 (2.76)	0.76 (2.21)	1.87 (2.23)
Observations	58	58	58	58
R^2	0.26	0.26	0.27	0.27
Adjusted R^2	0.13	0.12	0.14	0.13
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 15: Main model, excludes US

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean legislator birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	0.99^{**} (0.42)		0.56 (0.34)	
Single-Member	0.55 (0.48)		0.79^{**} (0.39)	
Share MTM		0.21 (0.50)		−0.21 (0.40)
Mixed-Member		-0.77^{**} (0.37)		-0.69^{**} (0.31)
Preferential Voting	-0.54^{*} (0.30)	−0.48 (0.30)	−0.19 (0.25)	−0.19 (0.25)
log(median DM)	−0.18 (0.11)	−0.16 (0.11)	−0.03 (0.09)	−0.03 (0.09)
log(Population)	−0.04 (0.16)	−0.04 (0.17)	−0.15 (0.13)	−0.15 (0.14)
log(Land area)	−0.16 (0.09)	−0.15 (0.10)	−0.09 (0.08)	−0.09 (0.08)
log(GDP p.c.)	0.31 (0.21)	0.33 (0.21)	0.14 (0.17)	0.14 (0.17)
Assembly Size	0.002 (0.001)	0.002 (0.001)	0.002^{**} (0.001)	0.002^{**} (0.001)
Democracy Score	−0.57 (0.40)	−0.61 (0.40)	−0.51 (0.32)	−0.51 (0.32)
Constant	1.14 (2.59)	1.78 (2.61)	3.47 (2.12)	4.33^{**} (2.12)
Observations	61	61	61	61
R^2	0.24	0.23	0.23	0.23
Adjusted R^2	0.10	0.09	0.10	0.10
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 16: Main model, controls for presidentialism

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean legislator birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	0.99^{**} (0.42)		0.57^{*} (0.34)	
Single-Member	0.47 (0.48)		0.76^{*} (0.39)	
Share MTM		0.27 (0.50)		−0.18 (0.40)
Mixed-Member		-0.73^{*} (0.37)		-0.68^{**} (0.30)
Preferential Voting	-0.52^{*} (0.30)	−0.46 (0.30)	−0.18 (0.25)	−0.17 (0.25)
log(median DM)	-0.20^{*} (0.11)	−0.17 (0.11)	−0.05 (0.09)	−0.05 (0.09)
log(Population)	−0.03 (0.16)	−0.04 (0.17)	−0.14 (0.13)	−0.14 (0.13)
log(Land area)	−0.15 (0.09)	−0.15 (0.10)	−0.07 (0.08)	−0.07 (0.08)
log(GDP p.c.)	0.29 (0.21)	0.31 (0.21)	0.13 (0.17)	0.13 (0.17)
Assembly size	0.002 (0.001)	0.002 (0.001)	0.002^{**} (0.001)	0.002^{**} (0.001)
Democracy Score	−0.57 (0.39)	−0.62 (0.39)	−0.53 (0.32)	−0.53 (0.32)
Presidential	−0.20 (0.27)	−0.16 (0.27)	−0.23 (0.22)	−0.24 (0.22)
Constant	1.43 (2.53)	1.99 (2.56)	3.47^{*} (2.07)	4.29^{**} (2.08)
Observations	62	62	62	62
R^2	0.25	0.24	0.25	0.25
Adjusted R^2	0.10	0.09	0.10	0.10
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 17: Main Model, interacts district magnitude (logged) and preferential voting

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean legislator birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	1.02^{**} (0.42)		0.58^{*} (0.35)	
Single-Member	0.47 (0.48)		0.82^{**} (0.39)	
Share MTM		0.30 (0.50)		−0.22 (0.41)
Mixed-Member		-0.74^{**} (0.37)		-0.72^{**} (0.30)
Preferential Voting	−0.87 (0.53)	−0.75 (0.53)	−0.33 (0.44)	−0.34 (0.44)
log(median DM)	-0.24^{*} (0.13)	−0.20 (0.13)	−0.05 (0.11)	−0.06 (0.11)
PV × log(median DM)	0.16 (0.21)	0.13 (0.21)	0.07 (0.18)	0.07 (0.18)
log(Population)	−0.06 (0.17)	−0.07 (0.17)	−0.15 (0.14)	−0.16 (0.14)
log(Land area)	−0.14 (0.10)	−0.14 (0.10)	−0.08 (0.08)	−0.08 (0.08)
log(GDP p.c.)	0.31 (0.20)	0.33 (0.21)	0.16 (0.17)	0.16 (0.17)
Assembly Size	0.002 (0.001)	0.002 (0.001)	0.002^{**} (0.001)	0.002^{**} (0.001)
Democracy Score	−0.60 (0.40)	−0.64 (0.40)	−0.55 (0.33)	−0.54 (0.33)
Constant	1.57 (2.56)	2.09 (2.58)	3.28 (2.12)	4.16^{*} (2.12)
Observations	62	62	62	62
R^2	0.25	0.24	0.23	0.23
Adjusted R^2	0.10	0.09	0.08	0.08
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 18: Main model, number of districts used instead of median district magnitude

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean legislator birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	0.82** (0.39)		0.48 (0.32)	
Single-Member	0.20 (0.59)		1.01** (0.48)	
Share MTM		0.31 (0.62)		−0.47 (0.50)
Mixed-Member		−0.56 (0.40)		−0.77** (0.32)
Preferential Voting	−0.44 (0.29)	−0.40 (0.29)	−0.17 (0.24)	−0.17 (0.24)
No. Districts	0.002 (0.002)	0.002 (0.002)	−0.001 (0.001)	−0.0005 (0.001)
log(Population)	−0.02 (0.16)	−0.03 (0.17)	−0.13 (0.13)	−0.14 (0.13)
log(Land area)	−0.13 (0.09)	−0.14 (0.09)	−0.09 (0.08)	−0.08 (0.08)
log(GDP p.c.)	0.28 (0.21)	0.30 (0.21)	0.17 (0.17)	0.16 (0.17)
Assembly Size	0.001 (0.001)	0.001 (0.001)	0.002** (0.001)	0.002** (0.001)
Democracy Score	−0.53 (0.40)	−0.58 (0.40)	−0.54 (0.32)	−0.52 (0.32)
Constant	0.81 (2.49)	1.23 (2.58)	2.97 (2.03)	4.07* (2.09)
Observations	62	62	62	62
R^2	0.22	0.21	0.23	0.23
Adjusted R^2	0.09	0.08	0.10	0.10
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 19: Main model, control for countries with a residency requirement rule (USA, Argentina, Brazil, Chile, Taiwan, Ecuador), coded from Massicotte, Blais and Yoshinaka (2004).

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean legislator birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	0.99** (0.42)		0.54 (0.34)	
Single-Member	0.55 (0.46)		0.89** (0.38)	
Share MTM		0.22 (0.49)		−0.32 (0.40)
Mixed-Member		−0.77** (0.37)		−0.74** (0.30)
Preferential Voting	−0.53* (0.30)	−0.48 (0.30)	−0.20 (0.24)	−0.20 (0.24)
log(median DM)	−0.18* (0.11)	−0.16 (0.11)	−0.01 (0.09)	−0.02 (0.09)
log(Population)	−0.03 (0.17)	−0.04 (0.17)	−0.18 (0.14)	−0.19 (0.14)
log(Land area)	−0.15 (0.09)	−0.15 (0.10)	−0.10 (0.08)	−0.10 (0.08)
log(GDP p.c.)	0.33 (0.21)	0.34 (0.21)	0.12 (0.17)	0.11 (0.17)
Assembly Size	0.002 (0.001)	0.002 (0.001)	0.003** (0.001)	0.003** (0.001)
Democracy Score	−0.58 (0.40)	−0.62 (0.40)	−0.45 (0.33)	−0.44 (0.33)
Residency Requirements	−0.09 (0.47)	−0.07 (0.47)	0.48 (0.38)	0.47 (0.38)
Constant	0.90 (2.72)	1.63 (2.78)	4.16* (2.20)	5.13** (2.25)
Observations	62	62	62	62
R^2	0.24	0.23	0.26	0.25
Adjusted R^2	0.09	0.08	0.11	0.11
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 20: Main model, uses log transformation of the dependent variable.

	Dependent variable:			
	log(SURLI) (2005 benchmark)		log(SURLI) (mean MP birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	0.28^{***} (0.09)		0.15^{*} (0.08)	
Single-Member	0.18^{*} (0.10)		0.17^{*} (0.09)	
Share MTM		0.05 (0.11)		−0.04 (0.09)
Mixed-Member		-0.23^{***} (0.08)		-0.17^{**} (0.07)
Preferential Voting	-0.13^{*} (0.07)	-0.12^{*} (0.07)	−0.04 (0.06)	−0.04 (0.06)
log(median DM)	−0.04 (0.02)	−0.03 (0.02)	−0.002 (0.02)	−0.0005 (0.02)
log(Population)	0.01 (0.04)	0.005 (0.04)	−0.03 (0.03)	−0.03 (0.03)
log(Land area)	-0.05^{**} (0.02)	-0.05^{**} (0.02)	−0.03 (0.02)	−0.03 (0.02)
log(GDP p.c.)	0.08^{*} (0.05)	0.08^{*} (0.05)	0.02 (0.04)	0.02 (0.04)
Assembly Size	0.0003 (0.0003)	0.0003 (0.0003)	0.001^{**} (0.0002)	0.001^{**} (0.0002)
Democracy Score	−0.12 (0.09)	−0.13 (0.09)	−0.09 (0.08)	−0.09 (0.08)
Constant	−0.18 (0.55)	0.03 (0.56)	0.58 (0.48)	0.78 (0.49)
Observations	62	62	62	62
R^2	0.28	0.28	0.24	0.24
Adjusted R^2	0.16	0.15	0.11	0.11
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 21: Main model, SURLI expressed as the difference between real EMD and the mean of simulated EMDs, normalised by the standard deviation of the simulated EMDs.

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean legislator birth year benchmark)	
	(1)	(2)	(3)	(4)
Multi-Member	2.72^{**} (1.14)		1.75^{*} (0.92)	
Single-Member	1.68 (1.26)		2.36^{**} (1.02)	
Share MTM		0.50 (1.33)		−0.55 (1.07)
Mixed-Member		-2.21^{**} (1.00)		-2.09^{**} (0.81)
Preferential Voting	-1.38^{*} (0.82)	−1.23 (0.82)	−0.55 (0.66)	−0.56 (0.66)
log(median DM)	−0.43 (0.30)	−0.37 (0.29)	−0.05 (0.24)	−0.06 (0.23)
log(Population)	−0.07 (0.44)	−0.10 (0.45)	−0.35 (0.36)	−0.35 (0.36)
log(Land area)	−0.37 (0.26)	−0.36 (0.26)	−0.19 (0.21)	−0.19 (0.21)
log(GDP p.c.)	1.04^{*} (0.56)	1.07^{*} (0.56)	0.59 (0.45)	0.58 (0.45)
Assembly Size	0.01 (0.003)	0.01 (0.003)	0.01^{**} (0.003)	0.01^{**} (0.003)
Democracy Score	−1.80 (1.08)	-1.91^{*} (1.08)	-1.64^{*} (0.87)	-1.63^{*} (0.86)
Constant	−2.21 (6.81)	−0.17 (6.94)	3.24 (5.50)	5.73 (5.58)
Observations	62	62	62	62
R^2	0.24	0.23	0.27	0.27
Adjusted R^2	0.11	0.10	0.14	0.14
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 22: Main model, no logged population controls.

	Dependent variable:			
	SURLI (2005 benchmark)		SURLI (mean MP birth year)	
	(1)	(2)	(3)	(4)
Multi-Member	1.00^{**} (0.41)		0.62^{*} (0.34)	
Single-Member	0.55 (0.45)		0.82^{**} (0.38)	
Share MTM		0.25 (0.47)		−0.16 (0.39)
Mixed-Member		-0.77^{**} (0.36)		-0.73^{**} (0.30)
Preferential Voting	-0.55^{*} (0.29)	-0.49^{*} (0.29)	−0.24 (0.24)	−0.25 (0.24)
log(median DM)	-0.18^{*} (0.11)	−0.15 (0.10)	−0.02 (0.09)	−0.03 (0.09)
log(Land area)	-0.17^{**} (0.07)	-0.17^{**} (0.07)	-0.13^{**} (0.06)	-0.13^{**} (0.06)
log(GDP p.c.)	0.31 (0.20)	0.32 (0.20)	0.14 (0.17)	0.13 (0.17)
Assembly Size	0.002^{*} (0.001)	0.002^{*} (0.001)	0.001^{**} (0.001)	0.002^{**} (0.001)
Democracy Score	−0.54 (0.37)	−0.58 (0.37)	−0.44 (0.31)	−0.43 (0.31)
Constant	0.78 (1.90)	1.37 (1.89)	1.74 (1.58)	2.57 (1.56)
Observations	62	62	62	62
R^2	0.24	0.23	0.22	0.22
Adjusted R^2	0.12	0.11	0.10	0.10
Note:				*p<0.1; **p<0.05; ***p<0.01

D Comparison of PR and SMD Tier (Germany)

Table 23 shows the share of 'parachuters' among MPs elected in the list-PR and nominal tier in German elections between 1998 and 2017. As in analysis of Italian legislators in section 5.1, we use Germany's 16 Länder (States) as the common reference geographical unit for both tiers: these correspond to the districts of the MTM and SM districts do not cross State borders. Hence, the figures for the share of parachuters in the SM tier differs slightly from those in table 7, where 'parachuters' are coded from the location of their birthplaces relative to the *single-member* district they were elected in.

Table 23: Share of legislators born outside of the State they were elected in, Germany 1998-2017.

Election	Share of 'parachuters'	
	list-PR tier	SM district tier
1998	0.44	0.33
2002	0.40	0.29
2005	0.41	0.25
2009	0.43	0.23
2013	0.41	0.23
2017	0.43	0.23
Overall	0.42	0.26

E Robustness Checks (Germany-Britain Comparison)

Table 24: Models from table 8 (UK case study) with additional controls.

	Dependent variable:		
	P(MP is a 'parachuter')		
	(1)	(2)	(3)
Party margin in previous election	1.00** (0.49)	1.08** (0.49)	0.99** (0.49)
Party[a]			
Labour	−2.27*** (0.82)	−2.47*** (0.82)	−2.25*** (0.83)
Lib Dem	−2.02** (0.96)	−2.10** (0.96)	−1.97** (0.96)
Other	−2.39** (1.04)	−2.31** (1.04)	−1.63 (1.39)
SNP	−2.07 (1.37)	−2.03 (1.38)	−1.58 (1.42)
Election[b]			
2005	−0.81 (0.83)	−0.88 (0.83)	−0.86 (0.83)
2010	−1.09 (0.76)	−1.17 (0.76)	−1.13 (0.76)
2015	−1.73** (0.78)	−1.84** (0.78)	−1.76** (0.78)
2017	−1.82** (0.84)	−1.85** (0.84)	−1.66** (0.84)
2019	−1.91** (0.76)	−2.02*** (0.76)	−1.93** (0.76)
By-election	−1.30 (1.38)	−1.61 (1.37)	−1.57 (1.37)
log(Constituency land area)	0.20*** (0.06)		
Constituency land area		0.0002* (0.0001)	0.0002* (0.0001)
Gender (male)		−0.20 (0.17)	
Country[c]			
Northern Ireland			−0.76 (1.16)
Scotland			−0.45 (0.34)
Wales			−0.33 (0.31)
Constant	1.56* (0.80)	2.72*** (0.75)	2.53*** (0.73)
Party × Election Interaction	Yes	Yes	Yes
Observations	864	864	864
Log Likelihood	−493.94	−497.01	−496.33
Akaike Inf. Crit.	1,057.89	1,066.02	1,068.67

[a] = ref. cat. Conservative, [b] = ref. cat. 2001, [c] = ref. cat. England
*p<0.1; **p<0.05; ***p<0.01

Table 25: Models from table 9 (Germany case study) with additional controls.

	Dependent variable:		
	P(MP is a 'parachuter')		
	(1)	(2)	(3)
Party margin in previous election	−1.59** (0.81)	−1.64** (0.81)	−1.53* (0.84)
Party[a]			
Other	−14.11 (882.74)	−14.01 (882.74)	−13.94 (882.74)
SPD	0.05 (0.56)	0.05 (0.57)	0.06 (0.56)
Election[b]			
2002	−0.39 (0.60)	−0.40 (0.60)	−0.38 (0.60)
2005	−0.26 (0.62)	−0.28 (0.62)	−0.25 (0.62)
2009	−0.72 (0.57)	−0.75 (0.57)	−0.73 (0.57)
2013	−0.57 (0.59)	−0.63 (0.59)	−0.64 (0.59)
2017	0.15 (0.57)	0.15 (0.58)	0.16 (0.57)
log(Constituency land area)	0.01 (0.08)		
Constituency land area		0.0002* (0.0001)	0.0001 (0.0001)
Gender (male)		−0.08 (0.20)	
Region (West)			−0.17 (0.25)
Constant	−0.43 (0.72)	−0.50 (0.57)	−0.41 (0.59)
Party × Election Interaction	Yes	Yes	Yes
Observations	604	604	604
Log Likelihood	−362.78	−361.12	−360.98
Akaike Inf. Crit.	763.57	762.25	761.96

[a] = ref. cat. CDU/CSU, [b] = ref. cat. 1998.
*p<0.1; **p<0.05; ***p<0.01