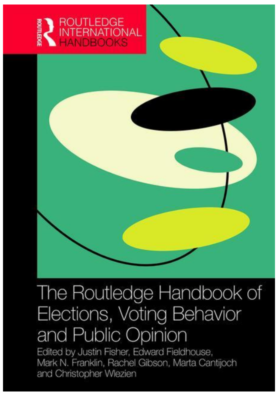

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38

THE USE OF AGGREGATE DATA IN THE STUDY OF VOTING BEHAVIOR

Ecological inference, ecological fallacy and other applications

Luana Russo

Introduction

A large part of the most prominent and seminal applied works in the field of voting behavior in political science is based on three major research schools: the School of Columbia, which focuses on the importance of social factors, the School of Michigan, which mainly focuses on party identification, and the rational choice theory, which stresses the importance of rationality, uncertainty and economic voting. The common trait of these three very prominent schools is that their theoretical approach and the applied evidences that they present are based on individual data (Lazarsfeld, Berelson and Gaudet 1944; Campbell et al. 1960; Downs 1957, among others).

After all, voting is an individual act, as individual as the decision-making process connected to it. It only seems self-evident that a large part of the literature on voting and political behavior employs individual data. However, aggregate data are also successfully employed in this field. There are two main reasons to employ aggregate data instead of individual data: first, the latter might not be available/reliable or, second, it might not be the most appropriate in order to answer a given research question which aims to explore a problem from its aggregate perspective.

In the first case, the researcher might want to employ the aggregate data to solve a puzzle at the individual level, whilst in the second he/she aims at exploring the aggregate level per se.

In the first case then, aggregate data are employed to infer individual behavior. This use of the aggregate data is called ecological inference and it is useful when the researcher is interested in the behavior of the individuals but the data are available only at the aggregate level (as for local or comparative electoral politics), unreliable (e.g., racial politics and abstention – areas in which respondents might feel pressured to answer in a certain way due to social desirability), inadequate (e.g., political and electoral geography – due to the unavailability of data sampled at the sub-national level) or unattainable (e.g., history – due to the lack of data) (King 1997). Hence, ecological inference is a mathematical solution to overcome a problem of data limitation – and the most immediate implication of having to deal with a limitation is that the solution is not free of limitations itself. The best way to study individual behavior is obviously to employ individual-level data. Trying to overcome the lack (or the unreliability) of data by using aggregate-level data entails two connected problems: the reliability of the estimates and the *ecological fallacy*, which is the incorrect assumption that the properties of the aggregate must apply to the individuals.

A typical example that fits the second scenario – trying to solve a puzzle that is inherently of aggregate nature – is the study of turnout (Franklin 2004: 16). In fact, the study of turnout from an aggregate perspective is rich in prominent contributions (see Geys 2006 and Blais 2007). A problem may arise when the individual decision of voting and the aggregate nature of turnout are not conceptually separated and the researcher assumes that the relationship found at the individual level can be applied also at the aggregate one (Alker 1969; Welzel and Inglehart 2007) – this is known as the *individualistic fallacy* and it is clearly the mirror image of the ecological fallacy problem.

This chapter aims at offering an overview of what the advantages and the limitations are when a researcher decides to use aggregate data – because those are the only (or the best) data available or because the focus of the analysis is on a concept that is aggregate in nature. Therefore, the chapter is mostly divided into two main parts: first it presents the problem of ecological inference and the related topic of ecological fallacy, it then continues by offering an overview of concepts and measures that are inherently aggregate.

Facing the problem: aggregate data to infer individual behavior

Ecological inference: the problem and an overview of the proposed solutions

The purpose of ecological inference is to infer the behavior of individuals by using aggregate data. The attribute *ecological* originates from the fact that aggregate data are normally issued at a territorial level – that is, from ecological units such as municipalities, constituencies, provinces, regions or countries. The problem is then to obtain an estimate of the behavior of the individuals in a given ecological unit from the information on the aggregate behavior. Table 38.1 shows a practical example from King (1997: 13).

As King (1997: 13) says: "The ecological inference problem involves replacing the question marks in the body of this table with inferences based on information from the marginal." Table 38.1 illustrates the typical ecological problem: for a given territorial area there are data available on (1) how many voters casted a preference for a certain party or did not go to the polls and (2) how many voters of a given ethnic background there are in the area of study. The information that is missing is how many voters for each of the given ethnic background voted, and, if so, for which party. In other words, as Table 38.1 shows, we know the marginal but we do not know how the marginal would be distributed in the cells. Several solutions have been proposed

Table 38.1 The ecological inference problem

Race of voters	*Voting decision*			*Total*
	Democrat	*Republican*	*No vote*	
Black	?	?	?	55,054
White	?	?	?	25,706
Total	19,896	10,963	49,928	80,760

in order to fill out the cells – and the variety of the solutions itself leads to the bottom of the problem: a fundamental indeterminacy (Duncan and Davis 1953; Tam Cho and Manski 2008; Elff, Gschwend and Johnston 2008). This is due to the fact that the available information is not sufficient to narrow down the feasible set of estimates to an interval that should include the parameter, unless strong assumptions are made. Elff, Gschwend and Johnston (2008) break down the fundamental indeterminacy into two different problems: (1) the modeling indeterminacy – which is linked to the exclusive use of aggregate variables: as long as only aggregate variables are present in the model there will always be multiple solutions (interrelations) to fill out the cells; and (2) the inferential indeterminacy: when a model is adopted, this model will rest on given restrictive assumptions about the population of interest – assumptions that cannot be tested if the only available variables are of aggregate nature. As Elff, Gschwend and Johnston (2008: 73) emphasize: "If the first problem is solved, the second problem is inevitably encountered. If one tries to avoid the second problem, one cannot solve the first one."

Actually, the first problem is mainly due to the will (or the necessity) to obtain point estimates – that is, to fill out the cells in Table 38.1 with one number. In fact, if one follows the Duncan and Davis (1953) approach, no assumptions are needed, but the cells will not be filled out with point estimates but with ranges. In other words, instead of having a single number estimate, one obtains an interval (with a minimum and a maximum bound) which comprises the estimate. The range of the bounds depends on the available data. In certain situations, a bound is sufficient to test a hypothesis and/or to look into a given phenomenon. However, point estimates are often required, and seem to be the most desirable outcome when looking at the flourishing literature that proposes models in order to solve the ecological inference problem.[1]

The key issue when using (or proposing a new) ecological inference model that provides point estimates is how one deals with the assumptions of that model. Each model entails specific assumptions, and the best-case scenario is that the assumptions can be tested. This is, however, rarely possible. Nonetheless, it is always possible to choose a model that is supposedly the best fit for the specific ecological inference problem that needs to be solved. A brief overview of the main logic of the Goodman (1953) and the Freedman et al. (1991) models might help illustrating the matter.

At the basis of the Goodman model (1953) is the "constancy assumption," which holds that the individuals belonging to a given group will behave similarly regardless of the ecological unit examined. It is possible to translate this assumption in a given scenario such as: voters of a particular ethnic origin will vote the same regardless of the neighborhood in which they live. Or: voters of a certain ideological persuasion will vote the same regardless of the municipality/province/region in which they live. Hence, the underlying assumption of this model is that the specific territorial context does not play an important role. In order to show how important these assumptions are in shaping the final model outcome – that is, the point estimates – Freedman et al. (1991) propose a neighborhood model that entails the opposite assumption with respect to the Goodman (1953) model. The neighborhood model adopts a constancy assumption that maintains that voters in the same neighborhood will vote similarly regardless of which particular ethnic group they belong to (or ideological view they hold).

As different assumptions will fit different situations, the variety of models proposed is not surprising. It may be argued that some models seem to be applicable in a wider set of situations than others, but in the end each researcher needs to identify the model that will fit his/her particular needs better.

Ecological fallacy

The previous section discussed how the fundamental indeterminacy that characterizes the possible solutions to the ecological inference problem leads to a multitude of approaches and models. But finding out what model will suit a given study (or a set of data) best is not the only hurdle. There is a widespread skepticism in the academic world about results obtained through ecological inference techniques (and aggregate data in general). This distrustful attitude is due to the fact that these results may be affected by an ecological fallacy.

The discussion on the ecological fallacy originates from the seminal work of Robinson (1950), who observed the inconsistencies between results obtained by performing correlations on individual- and aggregate-level data. Basically, by using the same set of data, Robinson (1950) showed that according to the level of data employed (individual or aggregate) the correlation estimate was different. Goodman (1953) reacted by arguing that if in general Robinson's (1950) argument was correct – and therefore the behavior of the individuals could not be inferred by only using aggregate data – "in very special circumstances the study of regression between ecological variables may be used to make inferences concerning the behavior of individuals" (Goodman 1953: 663). These *special circumstances* consisted of applying this model only when the constancy assumption would hold. This would apply in general to all models: they are intended to produce reliable estimates as long as the assumptions hold. However, the impossibility of empirically testing the assumptions does not provide the assurances that the estimates are free of ecological fallacy.

Welzel and Inglehart (2007: 304) suggest looking at the ecological fallacy debate from a completely new perspective by stating that "the prevailing conception of the ecological fallacy is itself fallacious." They challenge the assumption that in order not to be spurious (and, therefore, reliable) a relation has to appear in the same way both at the individual and at the aggregate level. In order to support their argument, they offer an example based on Weimar Germany, where there was a strong significant correlation between the Nazi vote and unemployment at the regional level. Research (Falter 1991) has shown that when analyzing this relation at the individual level unemployed people were not more likely to vote for Hitler. Do these findings imply that the correlation between unemployment and voting for the Nazis was not valid and therefore non-existent? According to Welzel and Inglehart (2007) this is not the case: considering what is found by using aggregate data as non-valid means plainly overlooking the fact that

> social phenomena, such as unemployment, do not have to influence the behavior of an individual as a *personal* attribute of this individual itself; they can also influence the behavior of an individual as an aggregate attribute of the population in which the individual lives.
>
> *(Welzel and Inglehart 2007: 304–306)*

In other words, being unemployed per se did not increase the *individual* chance to vote for the Nazis, but living in a region with a high unemployment rate did. Hence, both findings – the one at the individual level and the one on the aggregate level – are valid. In the authors' own words: "The fact that many characteristics affect individuals as aggregate attributes of their population, not as their personal attributes, is not an ecological *fallacy* but an ecological *reality*" (Welzel and Inglehart 2007: 306).

The authors take things a step further by arguing that denying the existence of the relation at the aggregate level can be identified as *individualistic fallacy*. The concept of individualistic fallacy was initially proposed by Alker (1969). If ecological fallacy consists in falsely assuming that a relationship found at the aggregate level could be assumed to exist at the individual level, the individualistic fallacy implies just the opposite, with the assumption that a relationship that exists at the individual level would also be found at the aggregate level.

Evidently, Welzel and Inglehart (2007) do not argue that ecological fallacies do not exist, but they warn about two risks: first, assuming that when using aggregate data an ecological fallacy problem would exist *tout court*; second, that if political science is pervaded by skepticism on the use of aggregate data due to the danger of incurring an ecological fallacy problem, the risk of running into an individualistic fallacy problem is widely overlooked.

Data: availability, reliability and feasibility

Considering the difficulties in selecting an appropriate ecological inference model and then trying to avoid ecological fallacy problems when interpreting the results, why is there such a lively debate on ecological inference and why do aggregate data continue to be widely used to infer the behavior of individuals? As mentioned before, there are many instances in which the use of aggregate data is the only or the best alternative to individual data. The most obvious is the unavailability of individual-level data. This might be the case for a comparative study in which the aim is to compare a large number of countries or when one is interested in carrying out a longitudinal (and comparative) study. The existence of large cross-national surveys is a relatively recent phenomenon whilst the chance that data exist at the country (or even local) level for a longer timespan is rather high. Hence, for research that aims to be largely comparative across time and space, aggregate data are often the only viable solution (see, for example, Fornos, Power and Garand 2004).

Lack of survey data can also cause a further problem: a researcher might be interested in studying sub-areas of a country (e.g., macro-areas, regions, provinces, municipalities) but the sample might be conceived to be representative at the national level, hence no reliable result can be obtained for the local level. This has been a serious problem in the advancement of many fields of political science, among which the studies on local voting and political behavior and the discipline of political geography, which had to almost exclusively rely on aggregate data (see, for example, Alford and Lee 1968; Wright 1977; Agnew 1996; Landa, Copeland and Grofman 1995; Shin and Agnew 2002, 2008). The lack of individual-level data at the local level can be ascribed to two connected factors: the large predominance in political science of the compositional approach (i.e., the tradition in which the explanatory role is reserved for the position of the citizen within society and his/her evaluation of the current political-economic situation, as is the case for the three major research schools mentioned in the Introduction) (Johnston and Pattie 2006)[2] and the large cost that a survey that would be representative at a sub-country level would entail.

The other key reason to decide to employ aggregate data alternatively or in addition to survey data is that the latter might pose problems related to their reliability. The reliability of survey data can be compromised by three main factors: technical issues (i.e., sampling errors), memory problems (recalling an electoral preference might be problematic, which poses a problem for studying volatility) and the topic under investigation (a citizen might not be willing to answer certain questions due to social desirability).

In fact, there is a rich literature that employs aggregate data in order to estimate electoral volatility between two elections at a national (see, for example, Agnew 1994; Landa, Copeland and Grofman 1995; Katz and King 1999; De Sio 2008; Russo 2014b) or municipal level (e.g., Landa, Copeland and Grofman 1995; Liu and Vanderleeuw 2001; Forcina, Gnaldi and Bracalente 2012), ticket-splitting (e.g., Johnston and Pattie 2000; Benoit, Laver and Giannetti 2004; Tam Cho and

Gaines 2004; Brunell and Grofman 2009), or in order to cross-validate or compare swing voter estimates obtained by survey data (Russo 2014a). Furthermore, aggregate data can also be employed for election forecasting – this is especially useful in the case of a very volatile electorate, a condition that can easily compromise the reliability of survey estimates, as they are largely based on past data (i.e., the *Seats-Votes model* proposed by Whiteley et al. 2011).

Finally, the topic object of the study might not be suitable to be investigated with survey data due to the insincere answers the study might obtain. This is notoriously the case when investigating turnout (Ansolabehere and Hersh 2012). In fact, it is well documented that surveys tend to overestimate electoral turnout (Selb and Munzert 2013) because of problems of over-representation and misreporting. The over-representation consists in over-representing voters that are interested in politics due to disproportionate self-selection in survey samples (Voogt and Saris 2003). This problem can be linked to two factors: the inclusion of actual non-voters who are not willing to declare they did not cast a vote for reasons of social desirability (Belli et al. 1999) or a sampling error consisting in selecting a sample that systematically over-represents voters and under-represents non-voters (Sciarini and Goldberg 2016). Once again, ecological inference models to cross-validate the survey data can be useful tools in this matter (Russo 2014a).

Aggregate data and aggregate concepts

Turnout, electoral volatility, nationalization

As the excellent argument put forward by Welzel and Inglehart (2007) suggests, certain phenomena are best observed at the aggregate level. In fact, these phenomena are aggregate by nature and definition. In this section, we offer three examples: turnout, electoral volatility and nationalization. Of course, these subjects are not even nearly an exhaustive list, but they do offer a clear illustration.

Turnout is one of the most investigated topics in political science. The phenomenon of turnout can obviously be studied from both an individual perspective (as the individual decision to cast a vote) and an aggregate one (e.g., the turnout of a municipality/region/country). As Franklin (2004) highlights:

> While voting is a matter of individual decisions, turnout is an aggregate-level phenomenon. It is a feature of an electorate not a voter. And, while it is true that electorates are made up of aggregates of voters, the process of aggregation is not simply one of adding up relevant features of the individuals who form part of it.
>
> *(Franklin 2004: 16)*

The study of turnout from an aggregate perspective is in fact rich in substantive prominent contributions (for a review on turnout literature at the aggregate level, see Geys 2006; for a theoretical overview on turnout on the aggregate level, see Blais 2007: 621–630).

Strictly connected to turnout, it is possible to identify another phenomenon that can be studied as aggregate: electoral volatility. Electoral volatility is also a very widely investigated phenomenon (Dalton 1984; Bartolini and Mair 1990; Dalton, McAllister and Wattenberg 2000; Mair 2002; Mair, Müller and Plasser 2004; Mair 2008, among others). Since the 1970s, when a process of voter de-alignment started, increasingly voters have shown to change their vote choice for parties from one election to another (Dalton and Wattenberg 2000; Franklin, Mackie and Valen 1992). As for turnout, if the decision of changing party is an individual attribute (see, for example, Dalton, McAllister and Wattenberg 2000; Lachat 2007), the level of volatility in, for example, a country, is an aggregate attribute (see, for example, Bartolini and Mair 1990; Tavits 2005).

Electoral volatility at the aggregate level can be studied as net volatility or total volatility. Net volatility entails the gains and losses of political parties participating in two consecutive elections (i.e., the change in vote share for each party). Total (or gross) volatility is the total proportion of voters who switched party (assuming a stable population of voters – which is an assumption that is almost impossible to maintain). It is evident that total volatility is less informative than the net one, but both share the problem of an almost certain underestimation of the real volatility. Consider the following (extreme) scenario: in a two-party system 50 percent of the electorate votes for party A and the other 50 percent votes for party B; at the consecutive election the two electorates make a perfect switch. In that case, both the estimated total and net volatility would (erroneously) be estimated as zero. Nonetheless, using a volatility index has the great advantage of potentially working with a large number of observations, as the data needed to compute the indexes (which will be presented in the next section) are easily obtainable (at the country, and often also at the sub-country level). This allows working with large comparative and longitudinal datasets.

Finally, another topic that is intrinsically aggregate is the nationalization of politics, generally defined as a long-term process resulting in the uniformity or universality of attitudes and political behavior within nations (Caramani 1996, 2004).The underlying logic of this process is that, as a result of the emergence of national electorates and national electoral systems (which in turn are due to the development of mass politics), the differences between the areas within a country gradually decrease, and eventually become minimal. In other words, as the local dimension of the cleavages decreases, national politics substitutes local politics (Caramani 1996, 2004). This nationalization process has been observed widely, both in Europe (Caramani 2004) and in the Americas (Alemán and Kellam 2008).

The whole process of the nationalization of politics can be conceptually divided into two related dynamics: the nationalization of the party offer and the nationalization of voters' electoral behavior. As both Morgenstern and Potthoff (2005) and Lago and Montero (2014) noticed, because of its intrinsically multidimensional nature, the concept of the nationalization of the party system has suffered from ambiguity.

The nationalization of the vote can be conceptualized and, consequently, measured in several different ways. Claggett, Flanigan and Zingale (1984) propose a comprehensive classification that distinguishes three different dimensions of nationalization:

1. *the homogeneity of the electoral support*, which implies that an election is nationalized when support for the parties is homogenous across the units of a country (Kasuya and Moenius 2008);
2. *the source (or level) of political forces*, that is, the tendency of the electorate to vote for national parties rather than local ones – this is a dynamic observed, for instance, in Italy (Caramani 2004);
3. *the type of the answer*, which entails a dynamic/time element: the election is considered to be a stimulus to which voters will respond and nationalization is operationalized as a uniform change across territorial units of a country between two elections (Russo 2014b).

Irrespective of which type of nationalization one wishes to study, none of them are observable at the individual level: the nationalization of the offer because it does not involve individuals but parties, and the nationalization of the vote because it is a phenomenon that is only observable in its aggregate nature.

Beyond ecological inference: other uses of aggregate data

When analyzing data of aggregate nature without wishing to make inferences about the behavior of individuals, the statistical techniques that are possible to apply are almost limitless. Aggregate data are normally interval-level data, therefore correlations, regressions and so forth can be used.

Turnout at the aggregate level has been used as a dependent or independent variable in regression models in a large amount of literature (see, for example, Powell 1986; Fornos, Power and Garand 2004; Fowler 2006; Riera and Russo 2016).

Unlike turnout, electoral volatility needs to be calculated as an index. The most famous index to calculate net electoral volatility is the index of dissimilarity (Pedersen 1979), which is the sum of the absolute changes in vote shares for each party divided by two, but several alternatives are available (see Taagepera and Grofman 2003).

Nationalization is also computed as an index, in case one wishes to measure nationalization both of the offer and of the vote. The indexes available for both kinds are very numerous (for a review, see Bochsler 2010; Lago and Montero 2014; Russo and Deschouwer 2015). In the field of the nationalization of the vote, the *standardized Party Nationalization Score* (Bochsler 2010) is the most widely accepted, whilst with regard to the nationalization of the offer Lago and Montero (2014) have elaborated the *local entrant measure* (E^1) that tries to overcome the limits of previously proposed indexes.

Finally, another interesting possibility that aggregate data offer is to analyze geographical patterns (see, for example, Rentfrow, Jokela and Lamb 2015, who investigates the existence of similar personality characteristics in neighboring regions), and to test geographical hypotheses (for example, as in Dejaeghere and Vanhoutte 2016, where the main assumption is that characteristics such as population density and immigration rate will influence turnout in local elections). In fact, as aforementioned, aggregate data can often be available at fine aggregation levels such as municipalities (as in Riera and Russo 2016) or even polling stations (Russo 2014a, 2014b). With fine sub-country data it is possible to apply advanced techniques (i.e., spatial lag models) that allow to verify whether the outcome observed in one area/unit is influenced by characteristics of the surrounding territorial units.[3] With regards to the aggregation level, one important aspect to take into account is that research has shown that the level of aggregation has an important impact on the quality of the estimates: the lower the aggregation level, the more reliable the estimates (Russo and Beauguitte 2014).

Conclusion

Aggregate data have multiple applications and great potential. They do not hold some of the great potential of individual-level data, but they can be a valid resource when there is a lack of individual-level data, and, more importantly, aggregate data are the right level of aggregation when one needs to study a phenomenon that is aggregate per se.

In this chapter, both scenarios have been illustrated. In the first part of the chapter, the main rationale of the ecological inference problem and the proposed solutions have been discussed. Then, the ecological (and individualistic) fallacy concept and the related debate have been presented. On this matter, it is important to stress once more that when analyzing a problem and commenting on the results, it is not the level of the data (aggregate or individual) that makes the quality of the findings, but the rigor in implementing and interpreting the analysis. The first part closes with an overview of possible settings in which the use of aggregate data can be the only or the best approach. The second part of the chapter focuses on the use of aggregate data when the topic under scrutiny is of an aggregate nature. Three examples have been offered: turnout, electoral volatility and nationalization. These topics do not represent an exhaustive list, but they have been selected (in this precise order of presentation) because they entail different levels of conceptualization and estimation. While turnout is a quite straightforward concept and not hard to measure – even though, as Geys (2006) notices, a certain level of clarification is required – electoral volatility needs to be computed as an index, and nationalization (also an index) involves a finer level of conceptualization. Many of the considerations made concerning the ecological fallacy apply to the second part of the chapter as well, especially the idea that certain attributes can be considered aggregate attributes of the population, and need to be examined at the aggregate level.

Finally, aggregate data seem to be the only viable solution when one is interested in exploring the geographical patterns of certain phenomena – at least until representative survey data are collected at a more local level.

Notes

1 For a more detailed explanation of some of the models, see Tam Cho and Manski (2008) and Elff, Gschwend and Johnston (2008).
2 Several authors argue that political behavior is not sufficiently informed about the role of territorial context. Franklin and Wlezien (2002) have noted that many of the factors that influence voting behavior are in fact geographically based and need to be incorporated into the analysis for us to be able to gain a better understanding. Despite the scholarly interest for the dimension of space and its analytical implications (Clark and Jones 2013), studies that have employed a territorial perspective are relatively few (Agnew 2002; Johnston and Pattie 2006) and lacking a comparative perspective, as they produced only "a large number of isolated findings but few generalizations" (Taylor and Flint 2000: 236).
3 For a technical overview of the mathematical operation of spatial models, see Franzese and Hays (2008).

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