

Visualizing subnational democracy in Colombia using Varieties of Democracy (V-Dem)

Merging V-Dem responses with municipal-level data

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Introduction

The objective of this methodological paper is to introduce geo-spatial mapping of democracy at the sub-national level using Varieties of Democracy (V-Dem) data. This effort in democracy studies is data-driven and descriptive (Coppedge 2012, 33–36). We describe the measurement process applied to one country (Colombia) in order to stimulate discussion on the methodological potential for V-Dem data to be used to measure democracy within countries. A main contribution of this project is a systematic and applied conceptualization of V-Dem data that can provide a granular-level measure of subnational democracy across time.

There are obvious limitations to mapping subnational V-Dem data. Primarily, expert interpretations of background concepts are themselves unobservable. The dichotomous format of the questions included in the survey are simplifications of much more contested concepts, such as development or illicit activity. Therefore, democracy scores rely heavily on how these concepts are interpreted by a relatively limited number of respondents. However, mapping provides a unique method for addressing these limitations because it integrates the use of empirical data with V-Dem responses. The combination of continuous empirical data with proportional responses related to the background concepts' salience in the country can produce a composite image of subnational democracy, and a meaningful tool for spatial analysis.

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This paper introduces a process for compiling and visualizing subnational data based on V-Dem, starting with the systematic conceptualization of the background concepts contained in the survey, assigning measures to those concepts on a geographic scale, and then identifying subnational scores. We demonstrate this process for a portion of the 21 response items in the survey.

The conclusion will discuss how these measurements could be combined or aggregated to provide estimations of the latent concepts of electoral fairness or civil liberty strength at the subnational level. We also discuss future exercises in validation (i.e., expert surveys, or comparison with other measures of subnational democracy) and replication (i.e., applying the same process to other countries). Finally, we suggest further exploring the causal relationships of first or second order complexity (e.g., the correlation of subnational democracy and development).

Relevance

The visualization of V-Dem scores has many potential benefits for comparative political analysis. First, this process provides a systematic method for integrating quantitative survey data into subnational research (Graudy, Moncada, and Snyder 2019). Many approaches to measuring subnational democracy have come across spatial dependence measurement issues (Harbers and Ingram 2017). Rather than spatial modeling, however, this inductive approach favors descriptive over explanatory inference, leveraging the systematic data generating process in V-Dem.

Rather than generating empirical data, V-Dem's subnational data generation process captures the level of agreement among expert coders on the relevance of within-country factors affecting democracy. These levels of agreement are reflected in proportional scores for the relative importance of a given variable, regardless of how the respondent conceptualizes it. When these proportions are interacted with the measurement of a systematized concept in geographic space, such as Gross Domestic Product (GDP) per capita measures for economic development in a given municipality or region, this produces unique observational data on the salience of democracy-shaping factors. When mapped, this creates a geographic visualization of weaker and stronger factors affecting subnational democracy, according to country experts.

This inductive approach has benefits and limitations.

- On the one hand, the interaction of salience with geographic data is descriptive rather than explanatory. It obviates the need for complex spatial analysis, privileging the latent nature of democracy as interpreted by country experts.

- On the other hand, the estimations are heavily influenced by coder interpretations of complex concepts. Some respondents may lack confidence around a factor and respond negatively, selecting 0 to signify “rejection” of the category rather than decidedness that a factor is irrelevant.

Nonetheless, this procedure represents a meaningful and transparent approach to measuring subnational democracy. The transparency behind this visualization procedure provides for validation and replication exercises. Once validated, these measures of subnational democracy can be used to test traditional hypotheses, such as whether development outcomes in subnational units are correlated with free and fair elections, or with the protection of civil liberties. We can use this data to examine the degree to which democracy is weaker or stronger in areas with illicit activity and economic productivity, and how tightly these variables are linked together.

Background: V-Dem data

In the V-Dem dataset, both Elections and Civil Liberties surveys contain four questions related to subnational democracy¹:

1. *How would you describe the areas of the country in which elections are significantly less free and fair?*
2. *How would you describe the areas of the country in which elections are significantly more free and fair?*
3. *How would you describe the areas of the country where government officials' respect for civil liberties is significantly stronger?*
4. *How would you describe the areas of the country where government officials' respect for civil liberties is significantly weaker?*

On average, a total of five country experts respond to these questions by making dichotomous selections (0 = no, 1 = yes) across 21 individual variables. These refer to levels of rurality, economic development, urbanization, regional locations, civil unrest, illicit activity, sparse populations, difficult access, indigenous areas, support for national ruling parties, and colonial rule. Experts may also provide text comments that clarify their selections.

The selections are then aggregated by coders to calculate the proportion of expert responses that selected “1” for a given variable. The results are country-year proportional scores for each variable between 0-1.

¹In the dataset, these questions are labeled: v2elsnlfc, v2elsnmrhc, v2clrgstch, and v2clrgwkch, respectively. Note that while these questions are complementary, they are framed to elicit an open range of responses.

These proportional scores reflect the degree of agreement or disagreement around the relevance of some background concepts conditioning subnational elections or civil liberties. For example, a proportional score of 0.8 suggests that 8 out of 10 experts agree that more economically developed areas have stronger civil liberties.

Uncertainty

V-Dem's subnational survey items encompass a wide range of background concepts, from geographic features (e.g., regions) to social phenomena (e.g., illicit activities), that may factor into or characterize subnational democracy. The complexity of these concepts produces a high degree of uncertainty around experts' interpretations and how they apply to the country in question. Moreover, some dichotomized concepts in the survey, such as "high/low economic development" or "strong/weak support for ruling parties", are best measured by continuous variables, such as GDP per capita or margin of victory. Respondents, however, must apply arbitrary thresholds to dichotomize these concepts, producing simplified generalizations.

Fundamentally, mapping subnational democracy faces many issues of measurement validity, what Adcock and Collier (2001) characterize as the movement between background concepts and observations.

- In mapping these concepts, the procedure outlined in this paper uses simple definitions and systematizes them by selecting one or two principal indicators for each response.
- Rather than discount alternative systematizations, our objective is to visualize the layering of these indicators that characterize subnational democracy in a given context, and therefore prioritize reliable over valid measurements.

Concepts, measures, and scores

This mapping procedure involves multiple stages, from the systematization of concepts with explicit definitions, to the assignment of measures based on coder responses, and finally the identification of subnational "scores" based on these measures.

Systematizing concepts

First, subnational V-Dem variables must be defined at "zero order complexity" (Coppedge 1999), balancing cross-national and context-based interpretations.

On the one hand, the cross-national nature of V-Dem surveys require the use of general rather than specific background concepts for measurement. For example, to assess the quality of subnational elections, the expert survey respondent is asked to consider the impact of “economic development” writ large across the country. The question does not specify a definition or threshold of development. Instead, the question allows for more than one interpretation. To ameliorate bias, the final country-year score for this indicator is the proportion of respondents that made the same assessment. While it may be preferable for respondents to refer to economic data for this question, this is beyond the scope of the survey. Moreover, without this step in generalization, V-Dem data would be unable to produce cross-national comparative data about the salience of attributes affecting subnational democracy.

On the other hand, country context is important for defining concepts and selecting appropriate indicators. This occurs for both fuzzy and less fuzzy concepts. For example, civil unrest and illicit activity are generally contested or fuzzy concepts. Moreover, they are difficult to observe and isolate as factors that affect democracy in the same way across contexts, even within countries. Taking illicit activity, for example, one area of the country with gang controlled neighborhoods may have limited voter turnout and less free elections, while another may tolerate or even encourage electoral competition (Córdova 2022). Even basic categorizations may be contested. For one expert, the North may include 10 provinces, yet for another it may include 8. Some knowledge about these context-specific contested concepts should inform the conceptualization process from the start, as these decisions will ultimately shape how subnational democracy levels are mapped.

After V-Dem responses have been conceptualized for the country in question, the operationalization of these indicators requires the use of external (within-country) data. This may come from a wide array of sources and formats. In Colombia, we consider the indicators as shown in Table 1. All sources in parentheses are official government sources, although alternative indicators and sources certainly exist.

Assigning measures

In order to visualize V-Dem responses in a geo-referenced environment, the operationalized country-specific indicators must be assigned some measure based on the proportional values recorded in each country-year. This requires a degree of subjectivity. For example, how many votes or proportion of votes are necessary to signify “strong” support for the ruling party (question 15)? Or, which municipalities are considered part of the “North” (question 6) versus the “West” (question 8)? We privilege the use of granular data that will allow researchers flexible interpretations of these questions, as well as subsequent validation from country experts.

Table 1: Operationalization of V-Dem responses in Colombia

ID	Response	Indicator
0	Rural	Rural Index (DANE)
1	Urban	
2	Less econ devt	Mun. Value Added / Dept. GDP (DNP)
3	More econ devt	
4	Inside capital	Geographic distance from center (DANE)
5	Outside capital	
6	North	
7	South	Six macro-regions (DANE)
8	West	
9	East	
10	Civil unrest	Illegally armed groups (Min. Defense)
11	Illicit activity	Coca cultivation (Min. Defense/UNODC)
12	Sparse pop.	Population density (DANE)
13	Remote	Access (Min. Transportation/Health)
14	Indigenous	Ethnic population (DANE)
15	Ruling party strong	
16	Ruling party weak	Pres. margin of victory (RNEC)

There are at least two approaches to assigning measures to V-Dem’s subnational response variables. One approach is to follow the dichotomous nature of the survey items themselves. In this way, municipalities would be categorized according to an arbitrary threshold, then assigned the value recorded in V-Dem. Another approach, which we pursue below, is to preserve the continuous nature of indicator data when available, and calculate values based on the cumulative distribution function (CDF) that can be interacted with V-Dem’s proportional responses.

- Either approach will produce novel measurements at the municipal-level that are compatible with variables beyond the V-Dem indicators.

Subnational democracy “scores”

Finally, the series of subnational V-Dem measures can be aggregated to produce composite scores. These will provide an initial measure of operationalized concepts, revealing geographically located “pockets” of stronger or weaker democratization in Colombia.

- Scoring is based on the aggregation of response values across all indicators. The advantage of using the CDF method is that the salience of each concept can be weighted to produce a final “score”.

Table 2: V-Dem response scores for Colombia in 2018

Survey variable	Elec. less free	Elec. more free	Civil lib. stronger	Civil lib. weaker
Rural	0.875	0.000	0.000	1.0
Urban	0.125	1.000	0.889	0.0
Less econ devt	0.875	0.111	0.000	1.0
More econ devt	0.125	0.667	1.000	0.0
Inside capital	0.000	0.889	1.000	0.0
Outside capital	0.375	0.000	0.000	0.6
North	0.250	0.222	0.333	0.1
South	0.250	0.000	0.000	0.5
West	0.125	0.000	0.111	0.3
East	0.125	0.000	0.111	0.3
Civil unrest	1.000	0.000	0.000	0.9
Illicit activity	0.875	0.000	0.000	0.9
Sparse pop.	0.375	0.000	0.000	0.6
Remote	0.875	0.000	0.000	0.8
Indigenous	0.500	0.000	0.000	0.9
Ruling party strong	0.000	0.222	0.333	0.0
Ruling party weak	0.000	0.000	0.000	0.1

Mapping exercise: 2018 cross-section of Colombia

This section describes in more detail a pipeline for mapping subnational democracy, and shows how conceptualization, measurement, and scoring occurs in practice. This exercise is designed to test the viability of mapping cross-sectional country-level data before expanding the dataset into panel format. Therefore, internal data from V-Dem is subset to Colombia for 2018, and the last five subnational responses related to foreign rule and “None of the Above” are removed because they are not relevant for these purposes. Table 2 shows the proportional scores for each variable, subset to Colombia in 2018, across the four survey questions in V-Dem.

The following sections show how data from external sources is collected and assigned 2018 V-Dem values. External data from Colombia is drawn from a variety of sources, but we do not discount the possibility of alternative data sources. In this exercise we also include visualizations to demonstrate how each factor appears depending on how V-Dem data is applied.

Three stages for mapping

For the purposes of replication, we can summarize the subnational mapping procedure into three stages.

The first stage is exploratory, identifying the level of analysis and available data for the systematized concept

in question. In this case, we observe that Colombia has publicly available municipal-level data dating back to at least the 1950s, at least for a relevant amount of time-varying variables reflected in the V-Dem responses (e.g., population density, economic development, voting behavior, etc.). We create a data-frame to join all data at the municipal level using national statistics department (DANE) codes. These codes are also used in shape-files and .dbf tables, such as Colombia's 2018 Census data from DANE². For practical purposes of data collection, some indicators (e.g., responses 6-9 that ask to identify 4 cardinal directions) are grouped together.

Second, we format the data for mapping purposes. This is a multi-step process whereby external geolocated data must be formatted and merged with V-Dem data. When data is continuous, as in the rurality index or economic development measures, for example, this merging process can take one of two forms. On the one hand, thresholds can be set to define the areas that correspond to each background concept. On the other hand, the data can be transformed using the cumulative distribution function (CDF) before being merged with V-Dem values. For categorical data (e.g., cardinal directions) only the first option is used. The sections below will consider both steps—thresholds and CDF—for assigning values and creating a measure for the relative salience of factors for subnational democracy, according to V-Dem country experts.

Finally, the responses are joined to shape-file data (.shp) and mapped using Geographic Information System (GIS) software. In R or in ArcMap, this can be done by joining data to the attribute table for the base layer (in this case, the shape-file provided by DANE). During this stage we create and format layers to show with less or more confidence where free and fair elections occur (and do not occur), and where civil liberties are stronger (or weaker), according to the respondents.

0-1: Rurality

The survey asks about elections and civil liberties in rural or urban locations. V-Dem scores for these survey variables reflect the proportion of respondents who selected rural, urban, or both categories to describe election fairness and civil liberties.

Rurality or urbanization can be measured in many ways. The World Bank's [Rural Access Index \(RAI\)](#) or European Commission's [Global Human Settlement Layer \(GHSL\)](#) are exemplary GIS-based approaches.

[Waldorf and Kim \(2015\)](#) create an index that considers population size, density, remoteness, and built-up

²To facilitate integration of the datasets across software, we export the Census 2018 attribute table from ArcMaps to .csv format, then load this data into R, preserving only relevant variables for merging purposes. While we use DANE codes to merge external data using R, we use the 2018 Census variable "FID" to merge .csv files into ArcMap. This is because ArcMaps automatically translates some string variables (such as the DANE codes) into a numeric ones. For this reason, we integrate the FID variable for the individual .csv files we write. The Census data shape-file is useful for initial mapping visualization, containing not only the administrative boundaries but also contextual information. The [dictionary](#) is in the Github repository.

areas. In Colombia, [DANE \(2015\)](#) uses a classification based on OECD criteria that defines rural territories as those with 150 or fewer persons per kilometer squared (km^2), finding that over 75% of Colombian municipalities do not meet the threshold of 100 persons per km^2 . From another perspective, DANE estimates that close to 4/5 of the population lives in urban centers.

In this exercise, we take a demographic approach that considers the proportion of the municipal rural population over the total municipal population. This basic “Rurality Index” measure has a few advantages. First, it was created by the Economics Center for Development and Economy (CEDE) at Universidad de Los Andes, using official Census data from DANE. Second, this proportional measure provides a continuous scale of municipal rurality that can be interacted with the V-Dem score proportions for the first two variables. We demonstrate this process below.

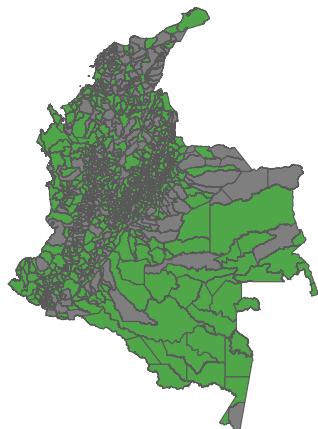
We can merge the rurality index with V-Dem scores in at least two ways. One option is to create a threshold for rural places and assign V-Dem scores accordingly. For example, we could take the mid-point as a threshold for rural and urban municipalities: if more than half of the population is considered rural inhabitants, then the municipality is considered rural. This method provides a first cut, and may be more intuitive to interpret. On the other hand, this approach involves the setting of arbitrary thresholds that may produce misleading results, especially given the cases grouped around the threshold.

Another option is to interact the rurality index with V-Dem scores and preserve the continuous nature of the data. We call this the Cumulative Distribution Function (CDF) approach because it creates a normalized value for the variable that can be interacted with V-Dem scores systematically.

Figure 1 depicts the results of these two approaches using the question: “How would you describe the areas of the country in which elections are significantly less free and fair” (`v2elsnlf`), and only looking at option #0: Rural. On the left side is the threshold approach and on the right side is the CDF approach. Clearly, the CDF approach provides much more detail than the threshold approach, which can only provide a simple visualization of areas categorized as rural. At the same time, the CDF approach creates a new continuous measure that is less straightforward to interpret. The CDF transforms the .875 proportion recorded in V-Dem for this year in Colombia and, when interacted with the rurality index, creates a variable whose municipal-level values range from 0.4377995 to 0.7361767. The benefit of using this variable, however, is that it provides a granular, empirically grounded estimate of the association between rurality and less free and fair elections. Because it is a normalized measure, this new estimate can be compared with the normalized values for other responses, resulting in a municipal-level estimate based on V-Dem experts’ assessments of the background concept’s relevance.

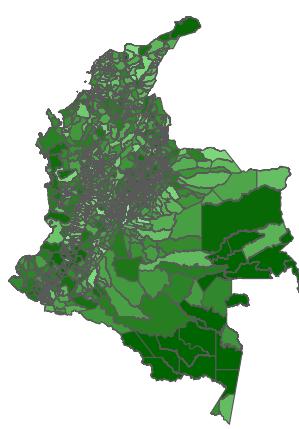
ould you describe the areas of the country in which elections are significantly less free ar

0. Rural.



Threshold approach

0. Rural.



CDF approach

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Of course, these composite municipal-level scores are heavily skewed by how the concept is systematized. In this example, we used a demographic measure—the rurality index—that relies on Census-defined parameters of what constitutes a rural inhabitant or not. Census measures may vary across countries, so the use of this measure may limit its use for cross-national comparative analysis. Nonetheless, as opposed to the threshold approach, the CDF approach takes advantage of the continuous nature of available data. Robustness checks using other continuous measures of rurality or urbanization would provide more confidence in the CDF approach going forward.

2-3: Economic development

Another advantage of the CDF approach is that it provides a straightforward method for V-Dem data to be scaled at different levels. This can be helpful when statistical data are missing at one level but not at another, or when respondents are likely to have multiple alternative interpretations. By contrast, the setting of arbitrary thresholds makes it difficult to scale data or to compare across measures.

In this section, we consider two measures of “economic development,” a variable that appears in the V-Dem survey under responses 2 (“Areas that are less economically developed”) and 3 (“Areas that are more eco-

nomically developed”), using multiple levels of analysis. This demonstrates how the CDF approach applied to economic and V-Dem data can provide a flexible tool for understanding multidimensional phenomena with many possible interpretations and comparable measures.

A common measure of economic development is GDP per capita, however this measure is problematic when scaled down to the subnational level. Indeed, according to DANE, only 41 countries in the world calculate regional or subnational GDP (“Buenas prácticas internacionales PIB regional” 2020). The difficulty may stem from the complex task of isolating economic productivity for subnational units when inhabitants may be undertaking inter-municipal daily commutes, for example, or when supply-chains overlap with multiple departmental jurisdictions. DANE provides subnational data for GDP (or Producto Bruto Interno, PBI, in Spanish) at regional and departmental (provincial) levels, but not at the municipal level. They calculate a historical “retropolation” of departmental GDP dating back to 1980.³

At the municipal-level, DANE has created a measure of municipal “value added”, which estimates the relative economic capacity of municipalities within each department by subtracting consumption levels from gross production (methodological documentation is included in the [repository](#)). Nearly all municipalities are measured by the Municipal Value Added (VAM) measure, however, data only exists from 2011 onward. It may be possible that V-Dem country experts are attuned to the economic disparities occurring within departments, and are considering how these affect electoral dynamics or civil liberties when responding to the subnational survey questions.

After compiling these data from DANE at municipal and departmental levels, we interact each of these measures with the V-Dem responses, as we did with rurality. Because data for both measures are continuous but not proportional, we must create new variables capturing the proportional weight for each department and municipality. Departmental GDP and municipal VAM data include outliers, especially at the municipal level. Because data is not normally distributed, we use the non-parametric empirical cumulative distribution (ECDF) function to scale them.

To demonstrate how the CDF approach facilitates scaling and comparison of V-Dem data at the subnational level, Figure 2 visualizes both measures for 2018. Clearly, there is missing data at the departmental level for the GDP measure given the presence of newer departments. Obviously, departmental GDP shows less variation than the municipal-level VAM measure. Nonetheless, there are some similarities around the center and western parts of the country across both measures.

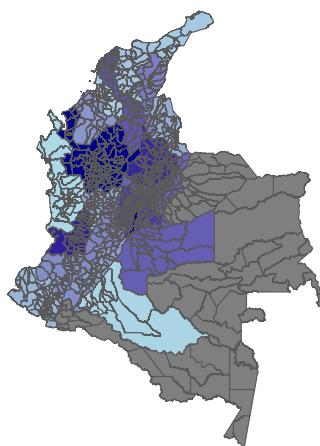
³Most departments are covered by the retropolation measure, but newer departments (many of which were inducted in 1991) are grouped into one unit, and therefore cannot be mapped based on DANE’s Departmental Code system without data intervention. These are: Amazonas (91), Arauca (81), Casanare (85), Guainía (94), Guaviare (95), Putumayo (86), San Andrés, Providencia y Santa Catalina (Archipiélago) (88), Vaupés (97) y Vichada (99).

The comparison shows that depending on the scale of the data and the economic measures used, one could reach different conclusions about experts' confidence around development levels and electoral fairness. Indeed, the northern region displays considerable divergence in V-Dem levels depending on the scale being used. On the other hand, the port city of Buenaventura on the Pacific coast is consistent across both scales.

To be sure, these visualizations provide a limited quantitative measure of V-Dem country experts' assessment of electoral fairness and economic development using the ECDF method. Additional quantitative and qualitative data from entities like the Election Observation Mission (MOE), for example, would provide additional analysis of electoral dynamics across the country that can further contextualize the role of economic development subnationally (Barrios Cabrera 2018).

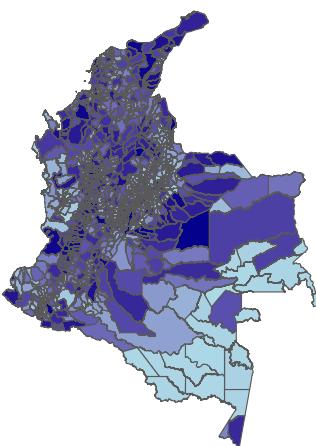
Should you describe the areas of the country in which elections are significantly more free and

3. Areas that are more economically developed



Department GDP (PBI departamental)

3. Areas that are more economically developed



Municipal Value Added (VAM)

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4-5: Inside or outside of capital city

The comparative approach can also be used to examine divergences in the degree of confidence across more or less free elections, or stronger or weaker civil liberties, given empirical data.

The survey asks about elections and civil liberties "Inside / Outside the capital city" (responses 4 and 5). In the context of the V-Dem survey, which is cross-national, respondents may reasonably interpret this

question to refer to the national capital (Bogota). University of Los Andes Center for Studies on Economic Development (CEDE) provides a measure for this variable for which we can merge V-Dem data using the CDF approach.

Although the survey asks two questions, the first (“Inside the capital city”) is one extreme of the second (“Outside”), so we create one continuous variable that reflects the relative proximity of municipalities from Bogota.

6-9: Cardinal directions

In order to map the four cardinal regions in Colombia, we are guided by external data from DANE who recently classified the country into 6 [macro-regions](#). We find a public-access table of municipalities classified into these regions [here](#). There are other divisions, such as the 5 regions used by CEDE studies (Andina, Caribe, Pacifica, Orinoquia, Amazonia), but for now we go with the prior classification.

We decide to group the regions in the following manner (see code below), creating a new variable called “Cardinal”. Then, we merge our V-Dem data related to responses #6-9 for each subnational survey question.

10: Civil unrest

11: Illicit activity

12: Sparse population density

- will likely covary with rurality

13: Remoteness

- will likely covary with rurality

14: Indigenous

15-16: National ruling party

The questions ask “Areas where national ruling party or group is strong / weak.” The most straightforward measure is a dichotomous variable where president receives a majority of the vote or not. A more variegated

measure can leverage the percentage of votes cast for the president-elect vs. runner-up, for example, however this measure may need to account for blank votes (which may signify protest votes).

The measure for ruling party support used here will be: % of vote that supports ruling party. For first wrangle, I will choose 2018 runoff election (second round) between Petro and Duque (Duque won, so his is ruling party). This makes things easier because there are only 2 candidates, the winner and runner-up. Elections without second rounds (prior to 1994, as well as 2002 and 2006) may require additional coding.

The voting data requires more steps for cleaning. In this exercise, we will take all possible vote entries: top 2 candidates, as well as no mark, blank, or null ballots. We see that Duque won by high margin (over 26% on average) in 2018.

After creating the data frame for voting behavior at the municipal level, we must decide on the threshold for “strong” versus “weak” support of the ruling party. We could take one standard deviation or higher as the threshold, but even so: what is the criteria? In the interest of simplicity, we will create a dichotomous measure, with margin of victory (MOV) above 10 percentage points, applied in either direction (positive for winner Duque; negative for loser Petro). This seems like a standard difference, but further research could guide this threshold setting. - ideally, don’t dichotomize. Use a continuous scale. - cl stronger where RP is stronger and experts agree that's

Exporting data

Mapping data can be exported to a shapefile then imported into `sf` or ArcMap

Conclusion

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