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GES 486

Spatial Analysis of Brazilian Income Using R

The research question for this project is to what degree is income clustered in Brazilian municipalities and whether there is a correlation with income and where banks are located throughout the cities. In cities throughout the world, there is a tendency for wealthy areas to cluster separately from low-income areas, this project aims to visualize the income segregation of different census tracts and how it correlates with where banks are placed within the metropolitan area of Sao Paulo and Belo Horizonte, Brazil. R studio will be used to extract and manipulate data and make plots. ArcMap will be used to clip the municipality borders and banks to later export into the R studio environment. LISA maps will be used to identify areas of clustering and an Ordinary Least Squares (OLS) Regression will be interpreted to quantify the statistical significance of the spatial relationship between banks and high-income neighborhoods.

To visualize the extent that which income is clustered in Brazilian municipalities and whether or not there is a correlation between the location of banks and high-income areas, I will first extract data using the geobr R package. I will get data for the metropolitan area of Sao Paulo and Belo Horizonte. For each, I will make a histogram showing the average monthly income versus the number of tracts, a map showing the average monthly income for each census tract, and a LISA map showing the clustering of high and low-income areas. For visualization purposes, I will also make a hexagon map of the average monthly income for each city. After, I will bring in the bank point shapefiles and overlay them on top of each city to see where they lie compared to the high and low-income areas. I will also make a hexagon map of the bank distribution. Lastly, to quantify the spatial relationship between where banks are located and where high and low-income census tracts are located, I will run an OLS regression model using R.

Brazil is known to be one of the most unequal countries on the planet in terms of economic inequality. Brazil's six richest men have the same wealth as the poorest 50% of the population and 16 million Brazilians live below the poverty line. (Oxfam International, 2019). Studies have shown that income segregation can contribute to high levels of homicides and social fragmentation. One study determined that for the ten most segregated cities of Brazil, it would be necessary to relocate more than 37% of families to make the spatial distribution of income homogeneous. (Santos et al. 2021). The purpose of this study is to visualize income segregation at the tract level in the

capitals of two southeastern states of Brazil. Also to emphasize that income segregation affects access to public amenities such as banks.

The census data is available on the IBGE website as zip files at https://ftp.ibge.gov.br/Censos/Censo_Demografico_2010/Resultados_do_Universo/Agregados_por_Setores_Censitarios/. Using R, I downloaded the MG_20171016.zip for Minas Gerais and SP_Capital_20190823.zip for Sao Paulo. The points shapefiles of banks in Brazil were downloaded online from map.igismap.com. Transformations were necessary for both cities when making the hexagon maps and subsets were created to get counts of bank points within each hexagon.

The output created in R shows us the extent that which income is segregated in Sao Paulo and Belo Horizonte. The histograms show how income is skewed to the left, and that there are significantly more census tracts with less income in each city. The maps of monthly income for each city show where wealthy areas lie and how they congregate. The LISA maps show the level that which high and low-income areas are clustered. The hexagon maps show the spatial distribution of income and banks in a visually appealing matter. The scatter plots show the number of banks within each hexagon according to income and lastly, the OLS regression model quantifies the statistical significance of the spatial relationship between banks and high-income areas.

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Citations:

Oxfam International. (2019, October 20). *Brazil: Extreme inequality in numbers*. Oxfam International. Retrieved May 19, 2022, from <https://www.oxfam.org/en/brazil-extreme-inequality-numbers>

Santos, M. I. dos, Santos, G. F. dos, Freitas, A., Filho, J. F. de S., Castro, C., Paiva, A. S. S., Friche, A. A. de L., Barber, S., Caiaffa, W. T., & Barreto, M. L. (2021, May 17). *Urban income segregation and homicides: An analysis using Brazilian cities selected by the Salurba Project*. SSM - Population Health. Retrieved May 19, 2022, from <https://www.sciencedirect.com/science/article/pii/S235282732100094X>

Resources used:

For OLS Regression:

<https://www.r-bloggers.com/2017/07/ordinary-least-squares-ols-linear-regression-in-r/>

For points in polygon:

<https://urbandatapalette.com/post/2021-08-tessellation-sf/>

For geobr package and brazil census data extraction:

<https://walker-data.com/census-r/working-with-census-data-outside-the-united-states.html#brazil-aligning-the-geobr-r-package-with-raw-census-data-files-for-spatial-analysis>