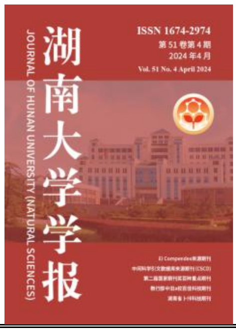

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Application of Spatial Regression to the 2017 DKI Jakarta Regional Election

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Abstract: The DKI Jakarta elections for 2017-2022 have captured the attention of researchers due to their intriguing nature. One particularly fascinating aspect is the unexpected victory of candidate pair (Paslon) number 3, Anies-Sandi, which was initially not favored by most opinion polls. This study explores how political preference factors, as described in the sociological model, contribute to the formation of base and non-base areas of Anies-Sandi voters in the DKI Jakarta elections for the 2017-2022 period. This study also evaluates the spatial impact of the influence of these social factors. The novelty of research that examines the application of spatial regression in the 2017 DKI Jakarta Pilkada is an interesting innovation that has never been studied before. The base and non-base areas are identified per sub-district with the location quotion (LQ) formula, whereas the identification of global spatial patterns uses the Moran index calculation formula. The free variables in the spatial regression model are designed to adopt a sociological model of political preferences that includes the free variables of sex ratio, percentage of young voters, percentage of highly educated population, percentage of formal sector workers, and percentage of non-Muslim population. The results of this study found that the Anies-Sandi base and non-voter base areas were spread to most sub-districts in DKI Jakarta, but their distribution did not form a particular global spatial pattern. However, it was found that there was an error-type spatial dependency in the first- and second-round LQ models, so it was necessary to perform spatial regression of errors. After spatial regression error, it was found that the sex ratio had a positive and significant effect on LQ in the first round, and the percentage of formal sector workers and the percentage of non-Muslim population had a negative and significant effect on LQ in the first and second rounds. Meanwhile, the lambda coefficient is positive and significant in the first and second rounds of the LQ error spatial regression models, which shows the spatial effect in the residual model. In terms of goodness of fit, the error spatial regression model is more efficient than the OLS model, which is indicated by the relatively low AIC value of the spatial error model compared with the OLS model.

Keywords: political geography, electoral geography, location quotion, Moran's index, spatial regression.

空间回归在 2017 年迪凯雅加达地区选举中的应用

摘要：2017-2022 年迪凯雅加达选举因其有趣的性质而引起了研究人员的关注。一个特别令人着迷的方面是第三号候选人（帕斯隆）阿尼斯-桑迪的意外胜利，该组合最初并未受到大多数民意调查的青睐。本研究探讨了社会学模型中描述的政治偏好因素如何有助于 2017-2022 年迪凯雅加达选举中阿尼斯-桑迪选民的基本区和非基本区的形成。本研究还评估了这

些社会因素影响的空间影响。2017 年迪凯雅加达皮尔卡达中空间回归应用的新颖性研究是一项以前从未研究过的有趣创新。使用位置引用（LQ）公式来识别每个分区的基地和非基地区域，而全局空间格局的识别则使用莫兰指数计算公式。空间回归模型中的自由变量采用政治偏好的社会学模型，其中包括性别比、年轻选民比例、受过高等教育人口比例、正规部门工人比例和非穆斯林比例等自由变量。人口。研究结果发现，阿尼斯-桑迪根据地和非选民根据地分布在雅加达迪凯的大部分街道，但其分布并未形成特定的全球空间格局。然而，发现第一轮和第二轮 LQ 模型中存在误差类型的空间依赖性，因此需要对误差进行空间回归。经过空间回归误差后发现，第一轮性别比对 LQ 有显着正向影响，而第二轮正规部门工人比例和非穆斯林人口比例对 LQ 有显着负向影响。第一轮和第二轮。同时，兰姆达系数在第一轮和第二轮 LQ 误差空间回归模型中均为正且显着，这表明了残差模型中的空间效应。在拟合优度方面，误差空间回归模型比最小二乘法模型更有效，这通过与最小二乘法模型相比空间误差模型的航空工业协会值相对较低来表明。

关键词：政治地理学、选举地理学、位置引用、莫兰指数、空间回归。

1. Introduction

Political geography is a branch of Human Geography that studies the relationship between political behavior and environmental features [1]. In this case, the political behavior of society is explained by attachment to the state of the surrounding environment, which includes the physical, economic, social, and cultural environment [1]. In the 1960s, political geography gave birth to a new branch, electoral geography [2]. Electoral geography highlights the role of space and locality in voting patterns. By examining voting patterns, researchers in electoral geography can analyze how spatial factors influence political competition within regions. This exploration allows a deeper understanding of how geographical differences can impact the outcome of elections [2].

In the international arena, geographical approaches to elections have found that people's political preferences are influenced by the environmental or locality circumstances of their neighborhoods [2]. A candidate's reputation can affect their electability in an area. In line with this, various spatial analyses conducted by Dow [3], Klos [4], Eskov [5], Valdez [6], Saib [7], and Ismail et al. [8] found that regional characteristics, including the physical, economic, social, and cultural environment of people in an area, affect the political preferences of those people.

Empirical findings from the perspective of electoral geography are consistent with the so-called sociological model of understanding political preferences. According to this model, choosing is not entirely a personal experience but a group experience [9]. In this model, factors thought to influence people's political preferences consist of education, occupation, religion, race, gender, and age [10].

The geographical approach, which agrees with the sociological model, can be a relevant approach in explaining the political preferences of the Indonesians. Indonesia comprises many diverse ethnicities, races, cultures, and spiritual beliefs. Based on population census data conducted by the Central Bureau of Statistics of the Republic of Indonesia in 2010, Indonesia has 1,340 ethnic groups. These variations are likely to impact the political preferences of the Indonesian population across different regions and play a significant role in shaping the electability of political candidates at both the national level, such as the presidential election, and the regional level, such as the election of regional heads.

Of the many political contestations in Indonesia, the victory of the Anies-Sandi candidate pair (prospective spouse) in the DKI Jakarta Regional Election for the 2017-2022 period is interesting to examine. The reason is that most survey institutions such as Charta Politika Indonesia, Indo Survey & Strategy, and Circle Survey Indonesia consider the prospective spouse Anies-Sandi inferior to the incumbent prospective spouse (Basuki-Djarot). In addition to his lack of experience, Anies-Sandi is considered inferior in the maturity of public policy programs. Not to mention, there is a positive sentiment toward the performance of the incumbent in the previous period as the LSI survey found that the level of public satisfaction with Basuki-Djarot's performance in the previous period was 73%, further strengthening the suspicion that Basuki-Djarot, not Anies-Sandi, would win the DKI Jakarta Regional Election for the 2017-2020 period.

Based on the above considerations, researchers are interested in studying the Anies-Sandi victory in the DKI Jakarta Regional Election for the 2017-2022 period through an electoral geography approach combined with sociological models. Researchers are interested in examining how political preference factors, as stated in sociological models, influence the formation of Anies-Sandi voter base and non-base areas, and examine the spatial effects of these social factors.

2. Methods

The analytical method employed in this study utilized quantitative analysis techniques, including descriptive and inferential analysis methods. Using descriptive analysis techniques, the researchers present a statistical summary of the number of observation units, minimum, maximum, average, and standard deviations of each variable. The researchers also visualize the Anies-Sandi voter base and non-base areas using a map. Meanwhile, the base and non-base regions will be identified using the location quotion (LQ) formula. Using inferential analysis techniques, the researchers present spatial analysis results in the form of explanatory spatial data analysis (ESDA) using the Moran index calculation. The Moran index is used to study whether the distribution patterns of the Anies-Sandi base and non-base voter regions form certain spatial patterns or are random. The researchers also present the results of spatial regression analysis (lag or error spatial regression models) of base and non-base regions by first testing spatial dependencies on the model using the Lagrange multiplier (LM) test. The results of spatial regression analysis will also be compared with the results of ordinary least square (OLS) regression analysis to determine whether spatial regression analysis can better explain the Anies-Sandi voter base and non-base area formation than OLS regression.

The data in this study are secondary, obtained from the Regional General Election Commission (KPUD) of DKI Jakarta Province in 2017 and BPS publications in the form of Districts in 2017 Figures. Adopting a sociological model, the independent variables in this study consist of sex ratio (RJK), percentage of novice voters (PPM), percentage of highly educated population (PPBT), percentage of formal sector workers (PPSF), and percentage of non-Muslim population (PPNM). The researchers also included a new independent variable, namely the level of population density (KP), to examine the influence of demography and space on the formation of the Anies-Sandi base and non-base areas.

Geographical approaches that use spatial analysis techniques require spatial weighting to give weight to neighboring areas. Spatial weighting is generally expressed with binary code in the matrix to express the relationship between one region and another [11]. The notion of proximity is based on territorial boundaries and distance. In the context of this study, the definition of proximity between regions is based on territorial boundaries, namely queen contiguity. Queen contiguity defines the neighborliness of territory like a queen piece in chess. In this case, areas whose sides and corners intersect each other are categorized as neighboring areas [12].

The unit of analysis in this study amounted to 42 units of analysis consisting of all sub-districts in DKI Jakarta Province in 2017. The research object was selected on the basis of the sub-district administrative units in DKI Jakarta Province in 2017, except for the South Thousand Islands and North Thousand Islands sub-districts. This selection was based on considerations to cover all relevant administrative areas of DKI Jakarta. The exclusion of the two island sub-districts is intended to avoid the existence of isolated units of analysis because queen contiguity spatial weighting only gives weight to areas that intersect directly.

3. Results and Discussion

Using the LQ formula, a sub-district is the Anies voter base if LQ is ≥1, and non-base if LQ<1. The LQ calculation formula is as follows:

$$\mathrm{LQ} = \frac{p_{ij}/p_J}{P_{ij}/P_J} \quad (1)$$

Notes:

Pij - number of valid votes for Anies-Sandi in the sub-district

PJ - total valid votes in the sub-district

Pij - number of valid votes for Anies-Sandi in DKI Jakarta

PJ - total valid votes in DKI Jakarta

On the basis of the results of the LQ calculation and descriptive statistical processing of independent variables, a statistical summary is obtained as follows:

Table 1 Statistical summary of dependent and free variables (Processed by the authors)

Variable	N	Minimum	Maximum	Average	Baku Crossing
LQ1	42	0.35	1.48	0.9869	0.19147
LQ2	42	0.59	1.24	0.9907	0.13009
KP	42	6573	50006	18514.21	9129.891
RJK	42	89	107	100.62	3.162
PPM	42	11.76	17.54	14.7155	1.05383
PPBT	42	6.40	31.69	15.4217	5.39984
PPSF	42	63.44	83.65	74.5614	4.50249
PPNM	42	4.83	53.10	18.5952	12.63446

Although there is a decrease in the maximum value of LQ2 compared with that of LQ1, the minimum point of LQ2 is well above the minimum point of LQ1 (Table 1). With an increase in the average LQ value of 0.0038, the average values of LQ1 and LQ2 tend to be close to 1. Thus, each sub-district in DKI Jakarta is almost entirely the area of the Anies-Sandi voter base on average. When examining the average of other variables, it is evident that DKI Jakarta has a high population density. The composition of the population in DKI Jakarta is predominantly Muslim and employed in the formal sector, indicating a proportional distribution.

The calculation results of LQ1 and LQ2 can be visualized in map form, as shown in Fig. 1. Based on Fig. 1, the Anies-Sandi voter base areas are scattered throughout the administrative regions in DKI Jakarta and form horizontal and vertical lines. Menteng, Tanah Abang, Johar Baru, Cempaka Putih, and Kemayoran sub-districts located in Central Jakarta City became the connecting point for the spread of the Anies-Sandi voter base area to various sub-districts in other DKI Jakarta administrative areas.

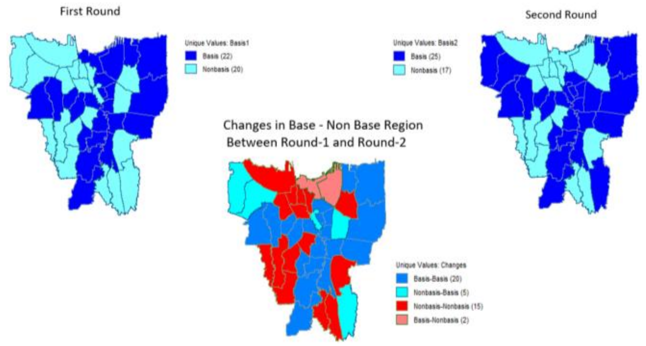

Fig. 1 Spatial distribution of base and non-base areas of Anies-Password voters (Processed by the authors)

Although in the second round, Tanjung Priok District and Pademangan District switched to non-base areas, five sub-districts, namely Kalideres, Cengkareng, Senen, Pulo Gadung, and Cipayung Districts, switched from non-base areas to the Anies-Sandi voter base areas. The increase in the number of base areas agrees with the increase in the LQ value in the second round. This also explains the adjustment of the preferences of residents who previously voted for Agus-Sylvi in the first round to choose Anies-Sandi in the second round, except in Tanjung Priok District and Pademangan District. The two sub-districts actually changed from Anies-Sandi voter base areas to non-base areas; therefore, without the participation of the prospective spouse Agus-Sylvi in the second round, most voters in the two sub-districts chose the prospective spouse Basuki-Djarot.

To determine whether the distribution of the regions in Fig. 1 forms a certain global spatial pattern, it is necessary to calculate the moran index. Here is the formula for calculating the moran index [13]:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_j-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}(x_i-\bar{x})^2} \quad (2)$$

Notes:
I – the Moran index
n - number of spatial units
xi - spatial unit variable value i
xj - value of the spatial unit variable j
wij - elements of the spatial weighting matrix

If I > 0, the autocorrelation value is positive, which indicates that the data form a group [13]. If I = 0, there is no spatial autocorrelation or the relationship between observation values in adjacent areas is random [13]. If I<0, the autocorrelation value is negative, which shows a disperse pattern [13].

To determine the significance of the Moran Index value, it is necessary to perform a significance test by calculating the statistical value Z of the Moran Index value and comparing it to the specified p-value. The hypothesis for testing the significance of the Moran index value is as follows:

H0: There is no spatial autocorrelation between the Anies-Password base and non-base regions.

H1: There is a spatial autocorrelation between the Anies-Sandi base and non-base regions.

The test statistics of the significance of the Moran Index value are [14]:

$$Z_{count} = \frac{I-E(I)}{\sqrt{var(I)}} \quad (3)$$

$$E(I) = \frac{n}{(n-1)} \quad (4)$$

$$Var(I) = E[I^2] - E[I]^2 \quad (5)$$

Notes:
E(I) - the Moran index expected value
var(i) - the Moran index variance
n - number of spatial units

With a significance level of a = 10%, the decision criterion for the hypothesis is "Reject H_0 if $|Z_{count}| > Z_{1-a}$."

The results of calculating the moran index can be presented in the form of a diagram, namely the Moran scatterplot diagram. Based on the results of calculating the Moran index of LQ1 and LQ2 values, I = 0.053 in LQ1 and I = 0.083 in LQ2 (Fig. 2). Although there was an increase in the Moran index value of 0.030 in LQ2, each value of I in each chart was not significant at a = 10%. Thus, it can be concluded that there is no global spatial pattern in LQ values, both LQ1 and LQ2, in sub-districts that intersect sides and angles.

Fig. 2 Moran's scatterplot LQ1 and LQ2 diagrams (Processed by the authors)

Although there is no global spatial correlation between Anies-Sandi base and non-base voter areas, it is possible that the formation of base or non-base areas in one sub-district is influenced by the formation of base or non-base areas in neighboring sub-districts. Therefore, it is necessary to test spatial dependencies, namely the Lagrange Multiplier test on the OLS model in this study. OLS models for the first (LQ1) and second (LQ2) round location quotion bound variables in this study are as follows:

$$LQ1=\theta 0+\theta 1KP+\theta 2RJK+\theta 3PPM+\theta 4PPBT+\theta 5PPSF+\theta 6PPNM+\varepsilon \quad (6)$$

$$LQ2=\theta 0+\theta 1KP+\theta 2RJK+\theta 3PPM+\theta 4PPBT+\theta 5PPSF+\theta 6PPNM+\varepsilon \quad (7)$$

After spatial dependency testing, it was found that the first and second round models had similar LM test results (Table 2). Both the LM lag and error are robust. This shows that the first and second round models have spatial dependencies; therefore, the analysis using OLS regression is potentially biased because the observed values that are considered independent among sub-districts are proven to be mutually independent. In addition, the results of the robust LM error test are more significant than those of the robust LM lag test. In other words, spatial dependencies in the first and second round models are caused more by correlation between errors (error-type spatial dependencies) than by the mutual influence of independent and bound variables between neighboring sub-districts (lag-type spatial dependencies).

Table 2 The Lagrange multiplier test results (Processed by the authors)

Test Statistics	**LQ1**	**LQ2**
Lagrange multiplier (lag)	0.5357	0.5357
Lagrange multiplier (error)	2.6413	2.6413
Robust Lagrange multiplier (lag)	6.3315**	6.3315**
Robust Lagrange multiplier (error)	8.4371***	8.4371***

* p-value<0.10; ** p-value<0.05; *** p-value<0.01

Based on the LM test results presented in Table 2, a spatial regression analysis can be conducted to examine the impact of each independent variable on the dependent variable within the model and its spatial effects. The spatial error regression model utilized in this study is outlined below:

$$LQ1=a0+\beta 1KP+\beta 2RJK+\beta 3PPM+\beta 4PPBT+\beta 5PPSF+\beta 6PPNM + \varepsilon \quad (8)$$

$$LQ2=a0+\beta 1KP+\beta 2RJK+\beta 3PPM+\beta 4PPBT+\beta 5PPSF+\beta 6PPNM + \varepsilon \quad (9)$$

where each ε in each error spatial regression model is

$$e = \lambda W e + u \quad (10)$$

Based on the models above, the coefficient of each independent variable in the spatial error model and OLS is obtained as follows:

Table 3 Free variable coefficients of error spatial regression and OLS models (Processed by the authors)

Variable	**Spatial Error Model**		**OLS Model**	
	LQ1	**LQ2**	**LQ1**	**LQ2**
Constant	-0.77491	1.4211**	0,13386	1,68059**
KP	3.43321	-1.30987	4,78793*	2,45454
RJK	0.02245**	0.00239	0,00978	-0,00619
PPM	0.02117	0.01289	-0,00333	-0,00168
PPBT	0.00364	-0.00497	-0,00127	-0,00884**
PPSF	-0.01006*	-0.00849***	-0,00039	0,00249
PPNM	-0.00679***	-0.00671***	-0,00669***	-0,00752
Lambda	0.48466***	0.3841**	-	-

* p-value<0.10; ** p-value<0.05; *** p-value<0.01

Based on the table above, the independent variables of percentage of workers in the formal sector (PPSF) and percentage of non-Muslim population (PPNM) in the spatial regression model error have a negative and significant effect on LQ1 and LQ2 values. The sex ratio (FSR) variability in the spatial error regression model was also positive and significant in LQ1. Unlike OLS, the spatial error regression model also found a new variable, namely lambda. The value of the lambda coefficient in the spatial error regression model represents the relationship between errors and their influence on the residual model. That is, there are positive and significant spatial effects on LQ1 and LQ2, but they have not been captured by the independent variables listed in the model.

In terms of goodness of fit, spatial error regression models are more efficient in explaining LQ, both LQ1 and LQ2. This can be inferred from the acquisition of each Akaike information criterion (AIC) value, where the AIC value of the spatial regression model error is smaller than that of the OLS model. The AIC value for OLS on LQ1 is -29.1404 and -86.4924 on LQ2. The AIC value for spatial regression error in LQ1 is -34.1534 and -86.8012 in LQ2.

4. Conclusion

Based on the results of the analysis and discussion, it can be concluded that the base and non-base areas of Anies-Sandi voters do not form a certain spatial pattern. However, there are robust spatial lag and error dependencies, where the robust LM error test value is more significant than the robust LM lag, so spatial regression is carried out using a spatial error regression model. Upon examining the coefficients of independent variables in the spatial error regression model, it is evident that the sex ratio variable has a positive and significant effect on the LQ of the first period, and the percentages of formal sector workers and the non-Muslim population have a negative and significant effect on the LQ of the first and second periods. Lambda in spatial error regression models has positive and significant coefficient values for LQ1 and LQ2, indicating a spatial effect in the residual model. In terms of goodness of fit, spatial error regression models are more efficient in explaining LQ, as seen from the relatively low AIC value of the model compared with the OLS model.

In terms of academic contributions, this research presents various innovations and important contributions to the political literature and research methodology. First, the use of spatial regression in the context of the 2017 DKI Jakarta elections is a new contribution that can expand our understanding of the factors that influence electoral dynamics at the local level. Second, the use of spatial error regression models to handle robust spatial dependencies provides a more careful and accurate view of spatial data analysis in a political context. Third, specific findings such as the influence of independent variables on the first- and second-period LQs and the presence of spatial effects on model residuals provide valuable insights for political practitioners, researchers, and policymakers to develop more effective and data-driven political strategies.

In addition to the aforementioned academic contributions, this study provides several recommendations that are of value to political practitioners, researchers, and policymakers:

4.1. Recommendations for Political Practitioners

The findings of this study can be used by political practitioners to better understand voter preferences and political dynamics at the local level. They can use this information to design more effective and data-driven campaign strategies.

4.2. Recommendations for Future Research

Future research can deepen our understanding of political dynamics at the local level by considering other variables that may affect election outcomes.

4.3. Research Perspective

In exploring more about political dynamics at the local level, future research could consider the influence of other factors such as cultural, historical, or geographical factors that may play an important role in election outcomes. In addition, combining a qualitative approach with spatial analysis may provide a more comprehensive understanding of the complexity of politics at the local level.

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