The Impact of Urbanization, Culture, and Wealth on Public Art in Toronto*

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Public art has emerged in many urban cities across the world. Existing research and analysis on public art often focuses on the impact of public art on various factors, making public art the explanatory variable. This paper examines public art as a response variable to explanatory variables such as population, minority population, and income as a measure of urbanization, culture, and wealth respectively with Public Art Data and Ward Data for the city of Toronto. Through data visualization, we find a moderately positive relationship between population and public art but no relationship between minority population and public art or income and public art.

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*Code and data are available at: https://github.com/alainahu/public_art

1 Introduction

Public art installations, or art pieces available to the general public in open spaces can be found in many urban cities across the world. The city of Toronto has over 400 public art installations provided by two organizations, Public Arts & Monument Collection and the Percent for Public Art Program. Public art not only enhances the urban environment, but it also brings together visitors and residents with local culture and history, creating an educational and bonding experience (Barone 2023).

Public art design is heavily integrated with urban planning and development as a whole. It is crucial for overall public art design to consider the overall coordination of the environment, meaning that public art should consider and reflect the environment that it is in (Meng and Ye 2022). Furthermore, public art is also an important symbol of maturity in a city (Liu 2021). Thus, our research is interested in the factors that influence public art design and selection of location. We analyze the trend between urbanization, cultural diversity, and wealth on the locations of public art installations in Toronto.

Existing research on public art often focuses on the effects of public art, making public the explanatory variable. Wright and Herman (2018) examine how public art created by Black artists in the Third Ward of Houston engages with gentrification and ghettoization. Smith (2014) looks at the effect of public art on societal interactions that reflect complexities of Egyptian society. Our research adds on to the literature by conducting analysis on public art as a response variable. While the societal and public art relationship could be bidirectional, we are interested in exploring the relationship between socioeconomic factors on public space usage with statistical methods. The estimand is the impact of population, minority population, and income on number of public art installations.

Our research paper begins with the Data section to visualize and further understand the measurement, source, methodology, and variables we are examining. Then, we introduce the Model used to understand the relationships in the data and report the findings in the Results section. Finally, we include the Discussion of the findings, summarizing the takeaway and future of this research.

2 Data

Data analysis is performed in `R` (R Core Team 2022), and additional help is provided by libraries such as `dplyr` (Wickham et al. 2023), `ggplot2` (Wickham 2016), `ggrepel` (Slowikowski 2024), `tidyverse` (Wickham et al. 2019), `kableExtra` (Zhu 2021), `knitr` (Xie 2023), and `sf` (Pebesma and Bivand 2023), `opendatatoronto` (Gelfand 2022), and `readxl` (Wickham and Bryan 2023). Data for this research comes from Open Data Toronto (Gelfand 2022), an open source data portal containing various topics of data for the city. For the data involved in this paper, we combine `Public Art` (Toronto 2023a) and `Ward Profiles (25-Ward Model)` (Toronto 2023b) In order to examine urbanization, cultural diversity, and wealth, we use population, minority population, and average household income as the explanatory variables to represent these factors. To analyze this trend across Toronto, we look at the effect of population, minority population, and average household income on the number of public art installations across the 25 wards of Toronto.

2.1 Public Art

The Public Art raw dataset includes information such as the source, artist, title, medium, installation year, and ward location on the 409 public art pieces in Toronto. Since we are only interested in the art pieces and their respective ward location, we focus on these two aspects of the data. As shown in Table 1, the data… . shows the part of the public art data we focus on.

Table 1: Sample of cleaned public art data

Art ID	Ward	Ward Name
1	14	Toronto-Danforth
2	13	Toronto Centre
3	11	University-Rosedale
4	11	University-Rosedale
5	14	Toronto-Danforth

2.2 Ward Profiles (25-Ward Model)

In the 25-Ward model, the city of Toronto is separated into 25 neighborhoods or voting districts. To better understand the effect of urbanization, cultural diversity, and wealth on the location of public art pieces, we compare the effect of population, minority population, income on the number of art works across the 25 wards. The `Ward Profiles (25-Ward Model)` data contains demographic, social, and economic information for each ward such as population, households, families, education, ethnocultural composition, spoken languages, income and housing costs. For our purpose of research, we are interested in population, minority population, and average income of each ward.. A sample of the cleaned dataset for the wards is shown below in Table 2.

Table 2: Sample of cleaned Toronto 25 Ward data

Ward	Population	Minority Population	Income
1	115120	90130	95200
2	117200	37210	146600
3	139920	48675	127200
4	104715	30445	127200
5	115675	67120	88700

2.3 Public Art by Ward

As we are interested in the number of public art pieces in each ward, we take the cleaned art data and group the wards together. To better understand our dependent response variable of the number of public art installations by ward, we organize the artworks by ward collect a count. Table 3 shows the number of art pieces by ward for the 25 wards of Toronto. To better visualize the spread of the number of pieces in each ward, we create a bar graph shown in Figure 1.

Table 3: Number of public art installations by ward.

Ward	Ward Name	Number of Public Art Pieces
1	Etobicoke North	1
2	Etobicoke Centre	3
3	Etobicoke-Lakeshore	13
4	Parkdale-High Park	23
5	York South-Weston	7
6	York Centre	9
7	Humber River-Black Creek	0
8	Eglinton-Lawrence	4
9	Davenport	0
10	Spadina-Fort York	157
11	University-Rosedale	46
12	Toronto-St. Paul's	14
13	Toronto Centre	61
14	Toronto-Danforth	12
15	Don Valley West	2
16	Don Valley East	2
17	Don Valley North	19
18	Willowdale	14
19	Beaches-East York	3
20	Scarborough Southwest	3
21	Scarborough Centre	11
22	Scarborough-Agincourt	1
23	Scarborough North	1
24	Scarborough-Guildwood	2
25	Scarborough-Rouge Park	1

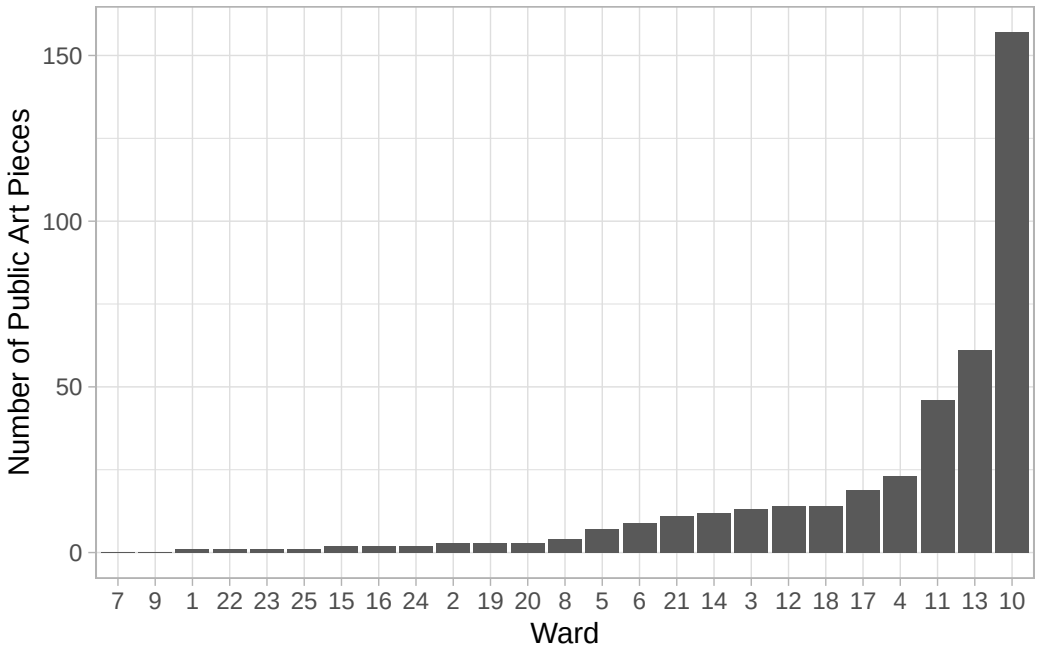


Figure 1: Number of public art installations by ward.

From Figure 1, we can see that Ward 10: Spadina-Fort York, Ward 13: Toronto-Centre, and Ward 11: University-Rosedale have the most number of public art installations while Ward 7: Humber River-Black Creek, Ward 9: Davenport, and Ward 1: Etobicoke North have the least number of public art installations. This aligns with intuition and literature regarding the connection between public art and urbanization. This can be visualized in the map below in Figure 2. The 3 wards with the most public art installations are highlighted. As shown, the wards with the most public art installations are in the main urban center of the city, Downtown Toronto.

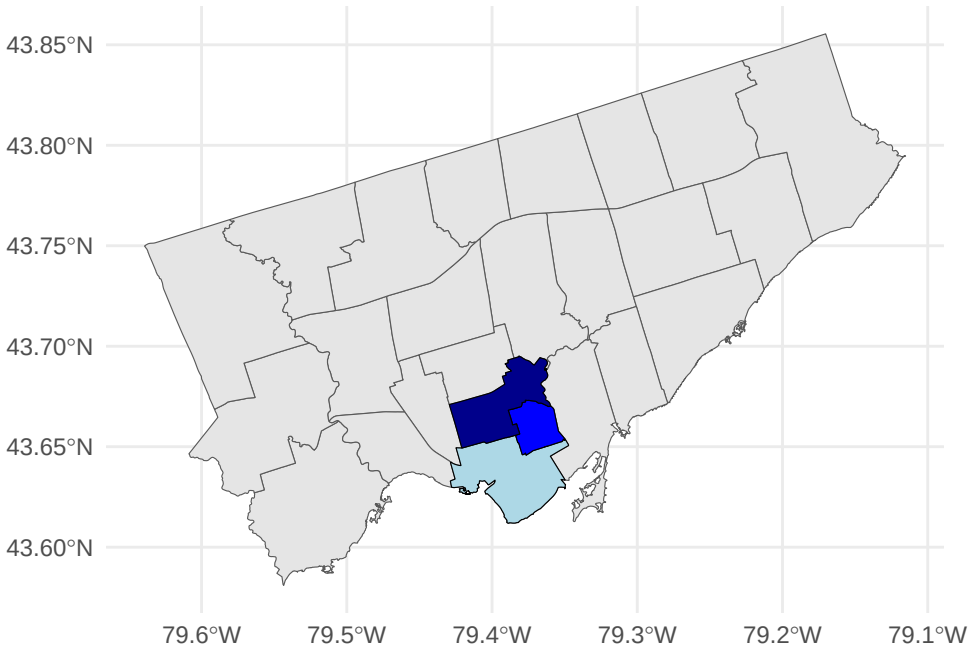


Figure 2: Map of Toronto highlighting the wards with the most art work

Table 4: Summary Statistics

Variable	Mean	Median	Standard. Deviation	Min	Max
Art Works	16.36	4	32.72	0	157
Population	120096.00	107300	33980.64	85700	224800
Minority Population	61492.00	67120	20380.90	30445	90130
Income	110451.60	110095	10593.87	94025	139920

2.4 Public Art, Population, Minority Population, Income by Ward

As the goal of this research is to analyze the impact of urbanization, cultural diversity, and income on the locations of public art pieces, we combine the Public Art Data grouped by ward with the Ward Profile Data to create the analysis data we are interested in. The analysis dataset includes the ward number, ward name, population of the ward, minority population in the ward, and average total income of households in 2020. Below in Table 5 is a sample of the analysis data.

Table 5: Sample of Data of All Variables

Ward	Ward Name	Population	Minority Population	Income	Public Art
1	Etobicoke North	115120	90130	95200	1
2	Etobicoke Centre	117200	37210	146600	3
3	Etobicoke-Lakeshore	139920	48675	127200	13
4	Parkdale-High Park	104715	30445	127200	23
5	York South-Weston	115675	67120	88700	7

2.4.1 Examining Population on Public Art

As one of our variables of interest, we are determined to examine the relationship between human population and the locations of public art at the ward level. We expect population and the number of public art installations to be positively related because the prosperity and development of cities provide space and development opportunities for the development of public art (Yin and Chang 2019). Public art is often a reflection of urban development, and population distribution is a direct proxy of urbanization (Qizhi, Ying, and Kang 2016). To visualize the relationship of interest, we plot population with the number of public art works.

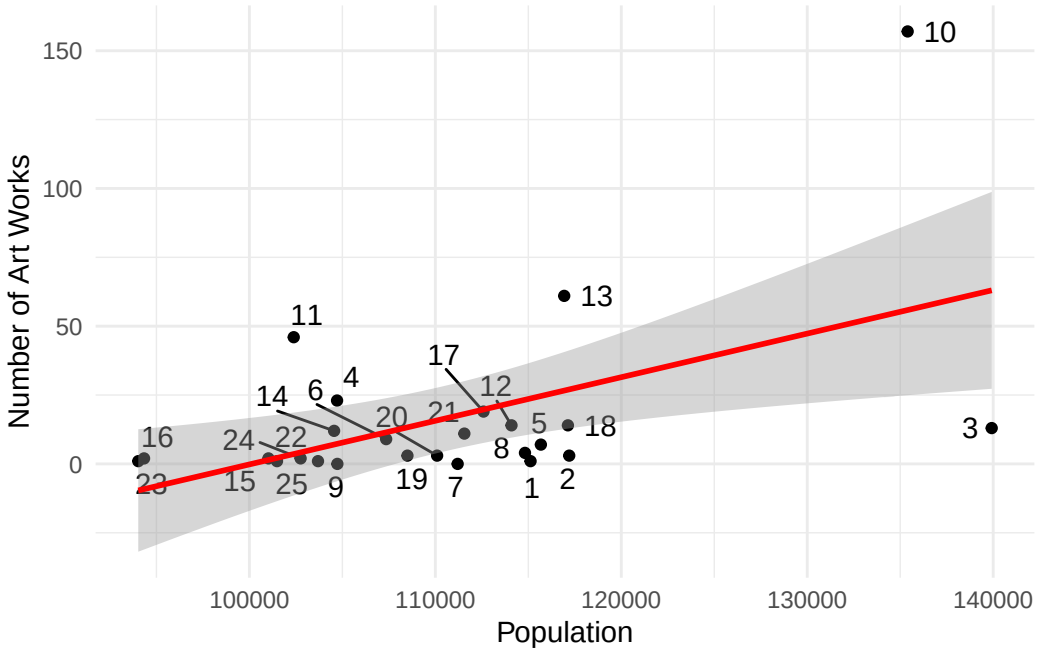


Figure 3: Plot of Population and Public Art by Ward

As expected, we see a moderate positive relationship between population of a ward and the number of public art installations in the ward. Furthermore, Ward 10 is an outlier and has both

a high population and high number of public art pieces. Intuitively, this aligns with our beliefs and confirms the trend between high population and urbanization with high concentration of public art pieces.

2.4.2 Examining Cultural Diversity on Public Art

Another explanatory variable we are interested in is the cultural diversity of a region. In this case, we visualize the relationship between minority population and the number of public art works per ward. We expect to see a positive relationship between these variables. Figure 4 displays the visualization.

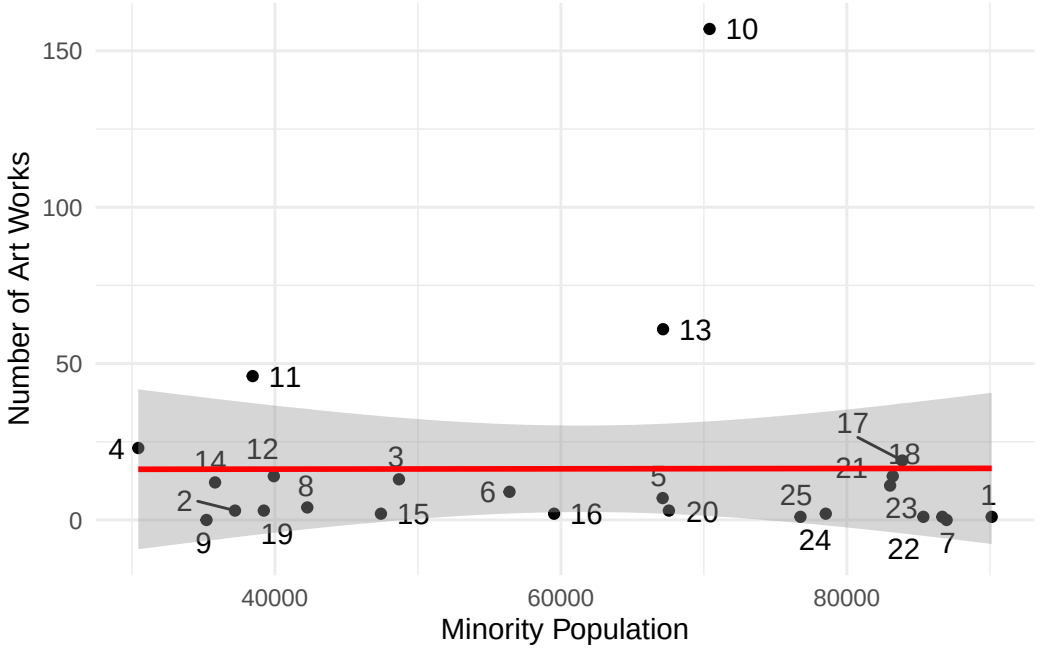


Figure 4: Plot of Minority Population and Public Art by Ward

Through the plot, we see that there is no relationship between minority population of a ward and the number of public art works in the ward. It is possible that the location of public art pieces is not a reflection of its cultural diversity. Ward 11 is in the Downtown region but has a lower minority population compared to Ward 13 and Ward 10, also wards located in Downtown. This observation leaves room for further research and investigation into the history and background behind Ward 11's population makeup.

2.4.3 Examining Income and Public Art

Lastly, in this research we are hoping to look at the relationship between income by ward and the number of public art pieces. Figure 5 plots the average household income in 2020 by ward with the number of art pieces by ward.

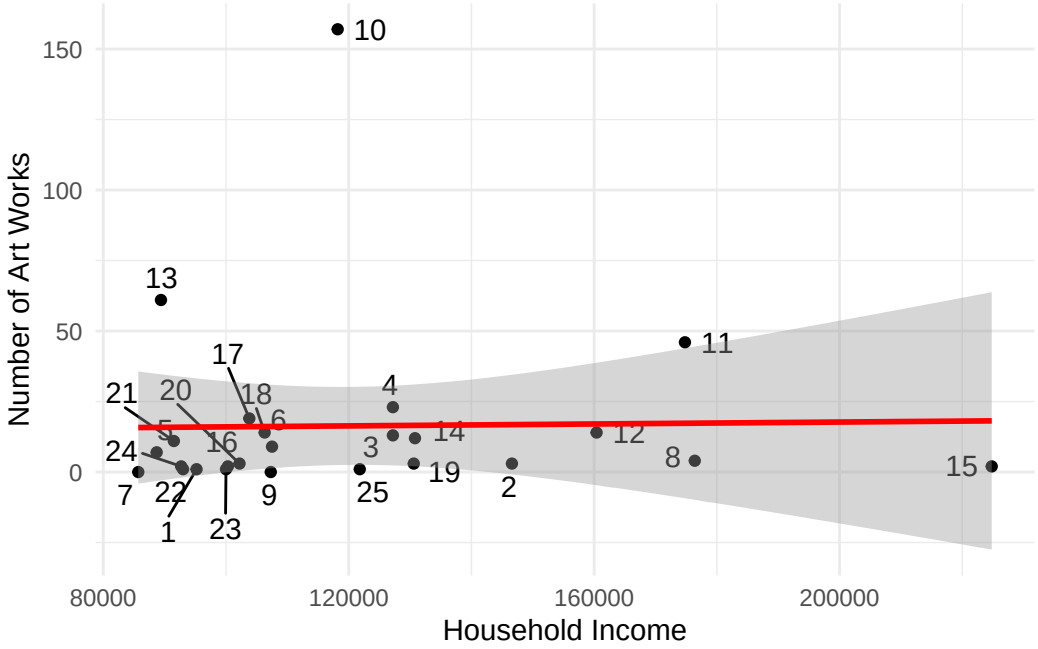


Figure 5: Plot of Income and Public Art by Ward

Similar to the relationship between minority population and public art, we observe no relationship between average household income level and public art.

3 Model

Here we briefly describe the Bayesian analysis model used to investigate.

3.1 Model set-up

From the data visualization performed in the Data section, we observe a moderately positive relationship between population and number of public art installations. First, we build a simple linear regression model to further explore the population and public art relationship. Next, we build a multiple linear regression model between all explanatory variables and public art. Although our data visualizations did now show any relationship between minority population

with public art and average household income level with public art, we add these two variables into the multiple regression model to act as controls. Through the multiple regression model, we are able to assess the number of public art installations related with population while adjusting for the explanatory variables of minority population and income.

3.1.1 Simple Linear Regression

Define y_i as the number of public art pieces in the ward i. Then $population_i$ is the population of ward i

$$
\begin{aligned}
y_i|\mu_i, \sigma &\sim \text{Normal}(\mu_i, \sigma) && (1)\\
\mu_i &= \beta_0 + \beta_1 \times \text{population}_i && (2)\\
\beta_0 &\sim \text{Normal}(0, 82) && (3)\\
\beta_1 &\sim \text{Normal}(0, 7.7) && (4)\\
\sigma &\sim \text{Exponential}(0.031) && (5)
\end{aligned}
$$

3.1.2 Multiple Linear Regression

Define y_i as the number of public art pieces in the ward i. Then $population_i$ is the population of ward i, $minority_i$ is the minority population of ward i, and $income_i$ is the average household income of ward i.

$$
\begin{aligned}
y_i|\mu_i, \sigma &\sim \text{Normal}(\mu_i, \sigma) && (6)\\
\mu_i &= \beta_0 + \beta_1 \times \text{population}_i + \beta_2 \times \text{minority}_i + \beta_3 \times \text{income}_i && (7)\\
\beta_0 &\sim \text{Normal}(0, 82) && (8)\\
\beta_1 &\sim \text{Normal}(0, 7.72) && (9)\\
\beta_2 &\sim \text{Normal}(0, 4.01) && (10)\\
\beta_3 &\sim \text{Normal}(0, 2.41) && (11)\\
\sigma &\sim \text{Exponential}(0.031) && (12)
\end{aligned}
$$

We run the model in R (R Core Team 2022) using the `rstanarm` package of (**rstanarm?**). Initially, we use the default priors from `rstanarm`, however, we allow `rstanarm` to improve the priors by scaling them based on the data. We allow auto-scaling and run both models with the updated priors specified above.

3.2 Model justification

Table 6: Explanatory models of public art works based on population

	Simple linear model	Multiple regression model
(Intercept)	−156.58	−172.93
	(63.73)	(83.09)
population	1.56	1.58
	(0.57)	(0.57)
minority_population		0.08
		(0.39)
income		0.06
		(0.24)
Num.Obs.	25	25
R2	0.239	0.280
R2 Adj.	−0.076	−0.135
Log.Lik.	−119.188	−119.735
ELPD	−126.6	−127.6
ELPD s.e.	11.3	10.5
LOOIC	253.2	255.2
LOOIC s.e.	22.7	21.0
WAIC	250.9	253.3
RMSE	27.54	27.54

4 Results

5 Discussion

From the data visualizations and observed relationships in the Data section, we see that there is a positive relationship between population and number of public art installations, but there is no relationship between minority population with number of public art pieces and income level with number of public art pieces. Perhaps there are better explanatory variables for the locations of public art installations than minority population and income of a region. After all, public art design is a complicated process and public space designers often have to make many decisions when selecting a location for a public art installation. Deeper research can better help us understand the process of urban public space design.

Further analysis can be conducted to verify the significance of the positive relationship between population and number of public art installations, meaning that we can check if the observed positive relationship is a result of chance or a verified trend.

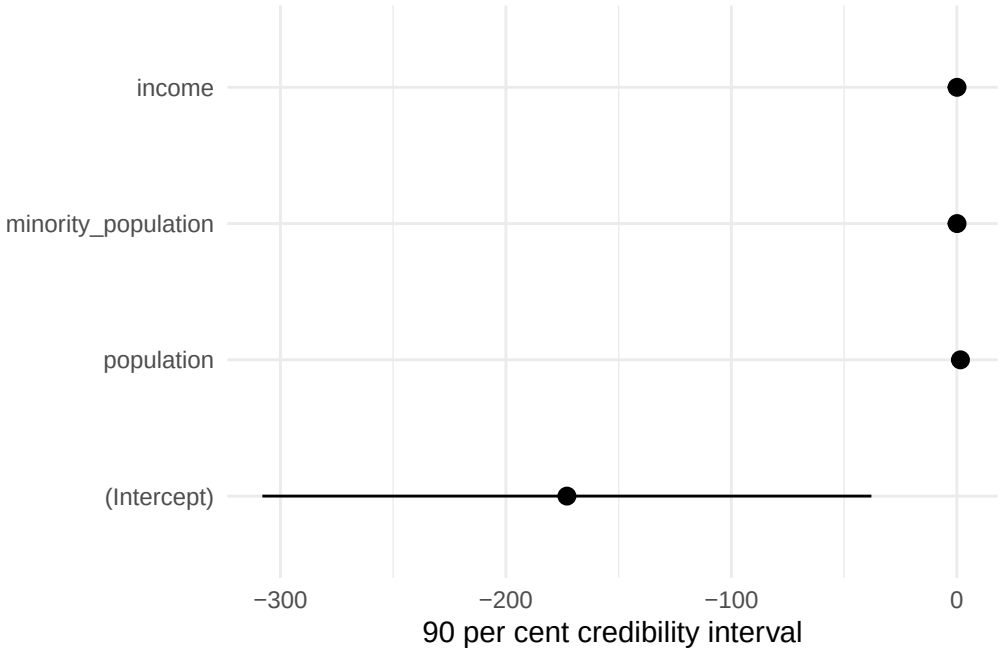
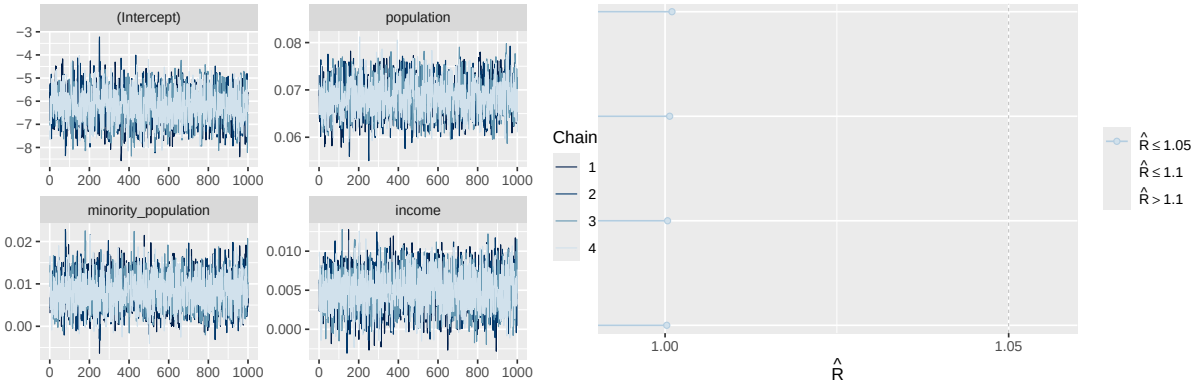


Figure 6: Explanatory models of public art works based on population



(a) Trace plot

(b) Rhat plot

Figure 7: Checking the convergence of the MCMC algorithm

6 Conclusion

With the purpose of investigating the relationship between urbanization, cultural diversity, and wealth on public art in Toronto, we find a moderate positive relationship between population and number of public art installations by ward. The research finds no relationship between minority population or wealth on the number of public art pieces. suggesting that there may be stronger factors that affect the locations of public art in the city. Further research could focus on the impact of population and urbanization on public art while searching for other potential variables of public art location.

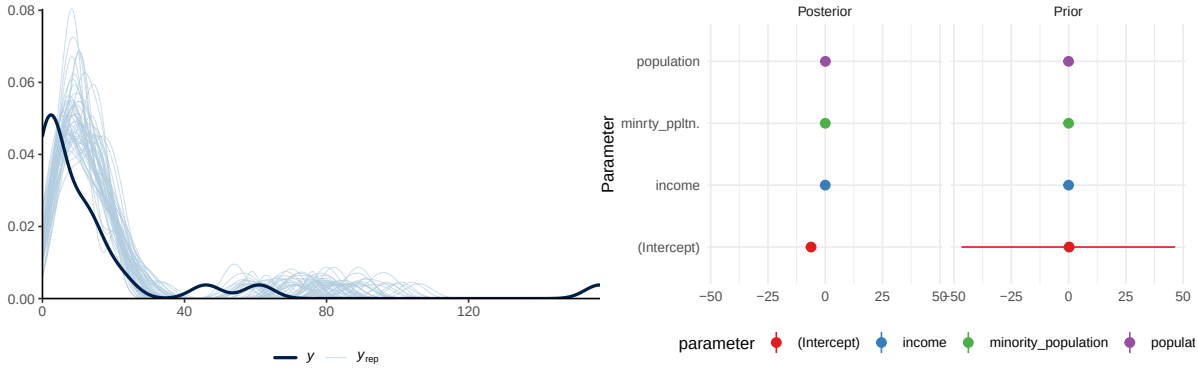
Appendix

A Model details

A.1 Posterior predictive check

In Figure 8a we implement a posterior predictive check. This shows the comparison between the actual outcome variable (public art installations) with simulations from the posterior distribution.

In Figure 8b we compare the posterior with the prior. This shows how much the estimates of the coefficients of our variables population, minority population, and income have changed once data was taken into account.



(a) Posterior prediction check

(b) Comparing the posterior with the prior

Figure 8: Examining how the model fits, and is affected by, the data

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