My title*

My subtitle if needed

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First sentence. Second sentence. Third sentence. Fourth sentence.

Table of contents

*Code and data are available at: LINK.

1 Introduction

You can and should cross-reference sections and sub-sections. We use R Core Team (2023) and Wickham et al. (2019).

The remainder of this paper is structured as follows. Section 2….

2 Data

Table 1: Sample of Cleaned Elections Data

Ward ID	Eligible Voter Turnout (%)	Number of Voters	Number of Subdivisions
1	24	16962	55
2	30	26784	72
3	33	33544	86
4	38	32223	70
5	28	21807	65

Table 2: Sample of Cleaned Toronto Ward Profile Data

Ward ID	Population	Uneducated Population (%)	Unemployment Rate (%)	Income
1	115120	18.997568	16.5	95200
2	117200	11.053754	12.8	146600
3	139920	9.269583	11.8	127200
4	104715	9.072244	12.9	127200
5	115675	21.750594	16.4	88700

Table 3: Sample of Combined Ward Election, Income, Employment, and Education Data

Ward ID	Name	Pop.	Num. of SubDiv	Uneducated Pop. (%)	Unemployment Rate (%)	Income	Voter Turnout (%)	Num. of Voters
1	Etobicoke North	115120	55	18.997568	16.5	95200	24	16962
2	Etobicoke Centre	117200	72	11.053754	12.8	146600	30	26784

Table 3: Sample of Combined Ward Election, Income, Employment, and Education Data

Ward ID	Name	Pop.	Num. of SubDiv	Uneducated Pop. (%)	Unemployment Rate (%)	Income	Voter Turnout (%)	Num. of Voters
3	Etobicoke-Lakeshore	139920	86	9.269583	11.8	127200	33	33544
4	Parkdale-High Park	104715	70	9.072244	12.9	127200	38	32223
5	York South-Weston	115675	65	21.750594	16.4	88700	28	21807
6	York Centre	107355	53	13.692888	14.1	107500	25	17124
7	Humber River-Black Creek	111200	47	23.080036	17.8	85700	22	14616
8	Eglinton-Lawrence	114820	64	10.490333	12.2	176400	32	25082
9	Davenport	104730	54	18.012986	13.1	107300	31	24869
10	Spadina-Fort York	135400	94	4.841211	9.8	118200	24	23293

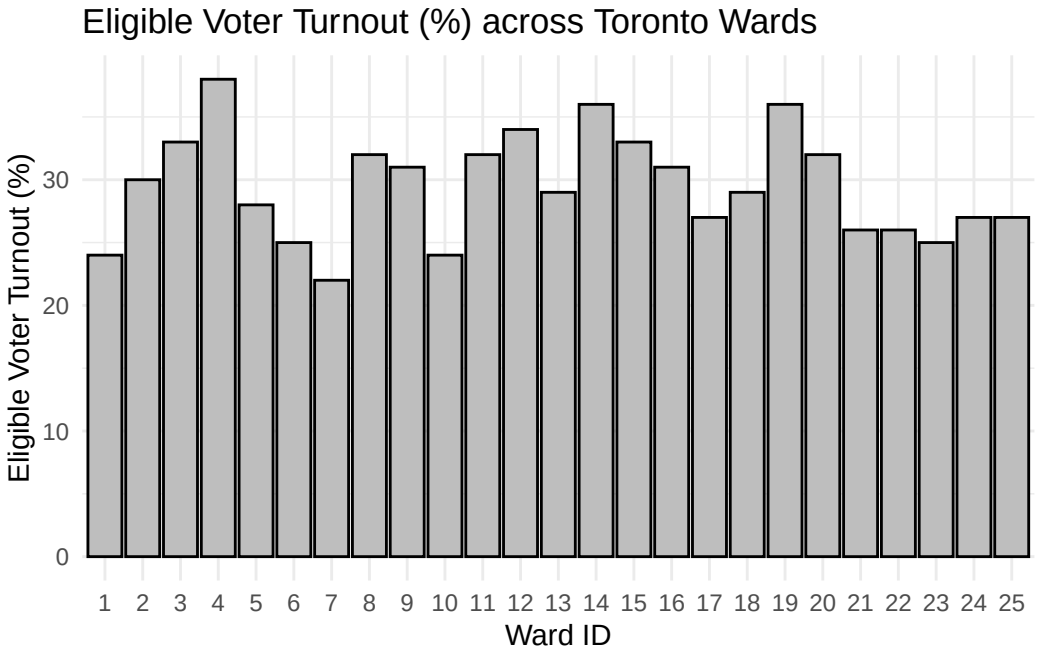


Figure 1: Voter Turnout (%) across Toronto Wards

Table 4: Summary Statistics

Variable	Mean	Median	Std. Dev	Min	Max
Income	120096.00	107300.00	33980.64	85700.00	224800.00
Number of Subdivisions	61.40	59.00	13.79	38.00	94.00
Number of Voters	22524.96	22522.00	5168.51	14616.00	33544.00
Population	110451.60	110095.00	10593.87	94025.00	139920.00
Voter Turnout (%)	29.48	29.00	4.22	22.00	38.00
Uneducated Population (%)	12.43	11.95	4.93	4.84	23.08
Unemployment Rate (%)	14.13	14.10	2.11	9.80	17.80

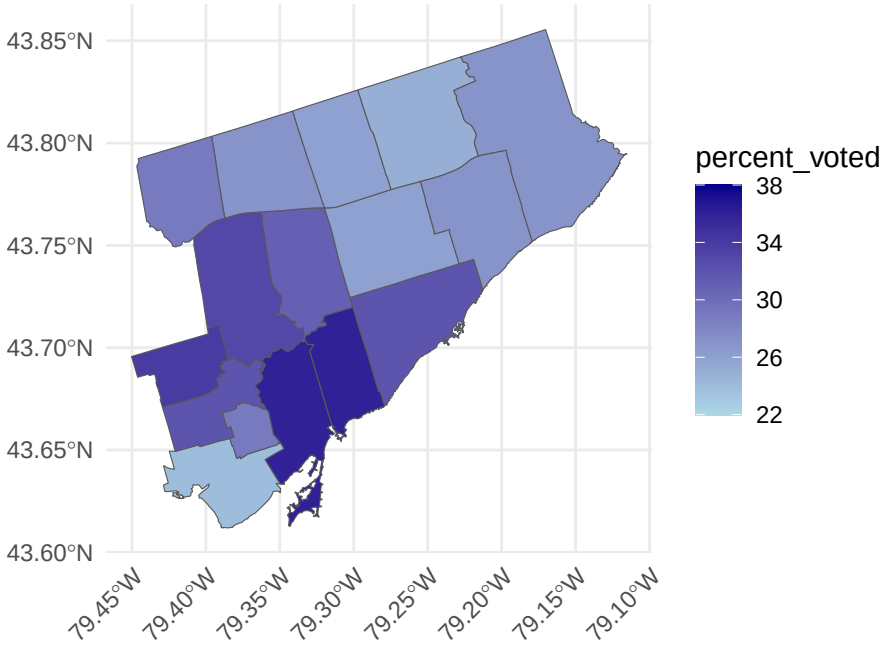


Figure 2: Map of Toronto highlighting the voter turnout across wards

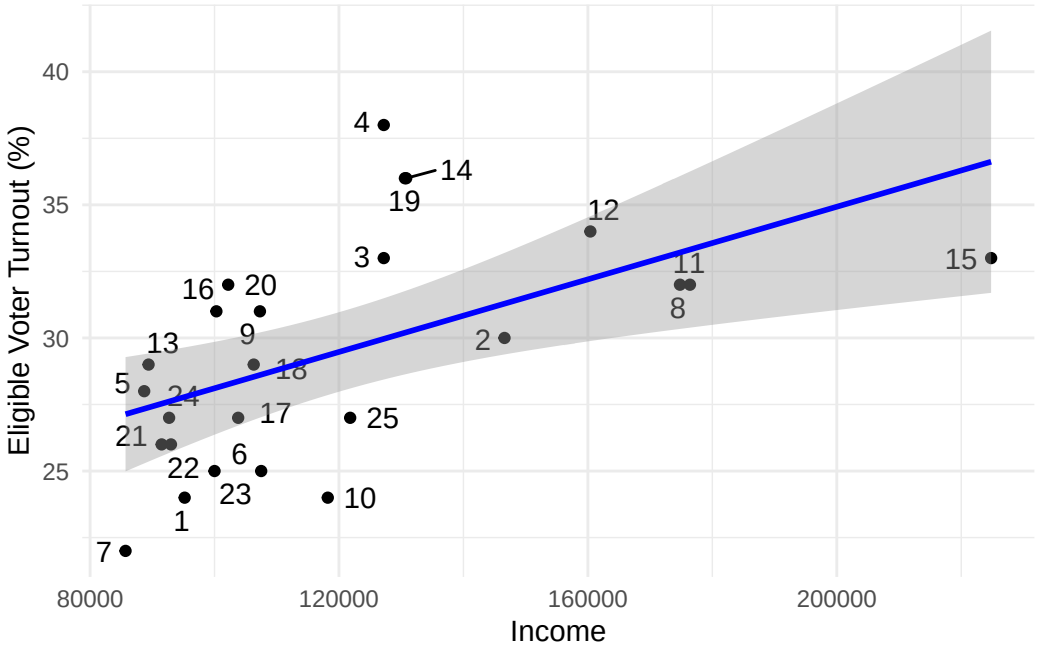


Figure 3: Correlation between Eligibile Voter Turnout and Ward's Income

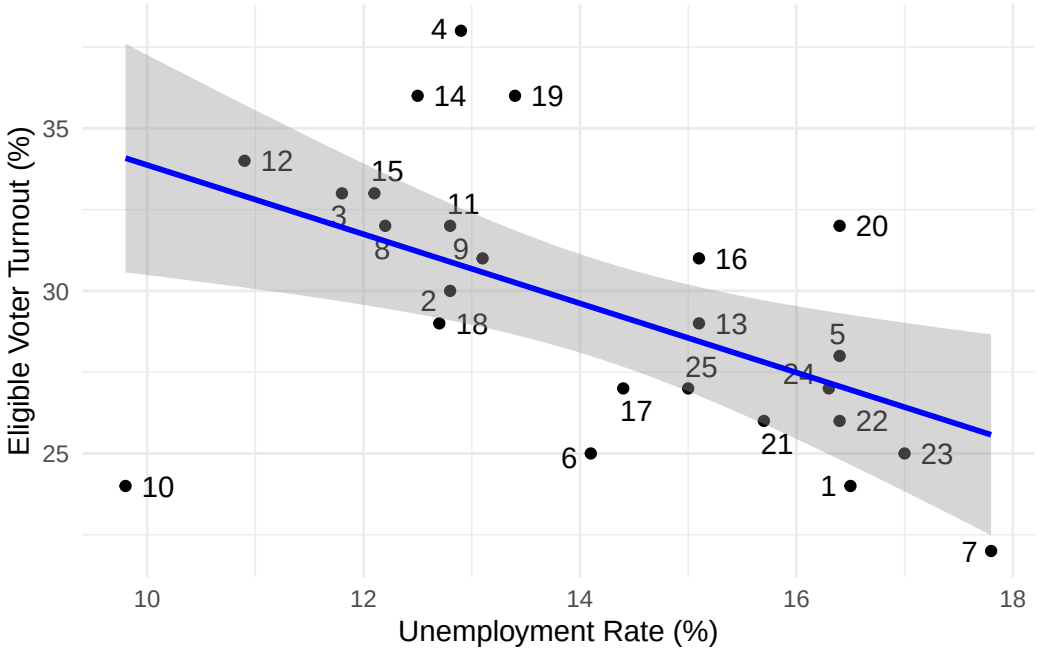


Figure 4: Correlation between Eligibile Voter Turnout and Ward's Unemployment Rate

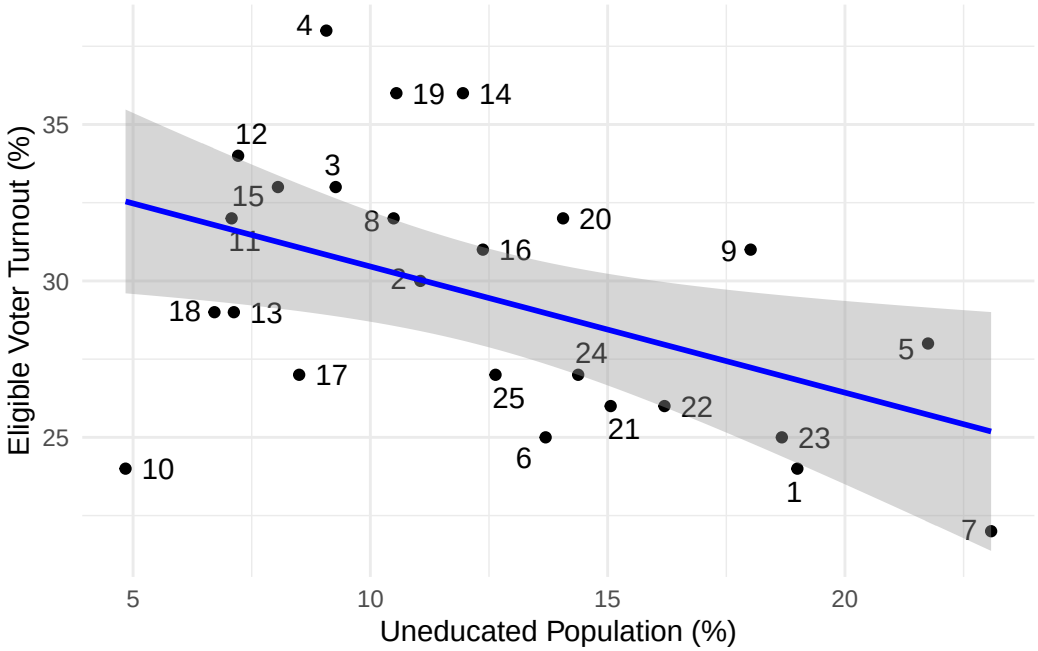


Figure 5: Correlation between Eligibile Voter Turnout and Ward's Level of Education

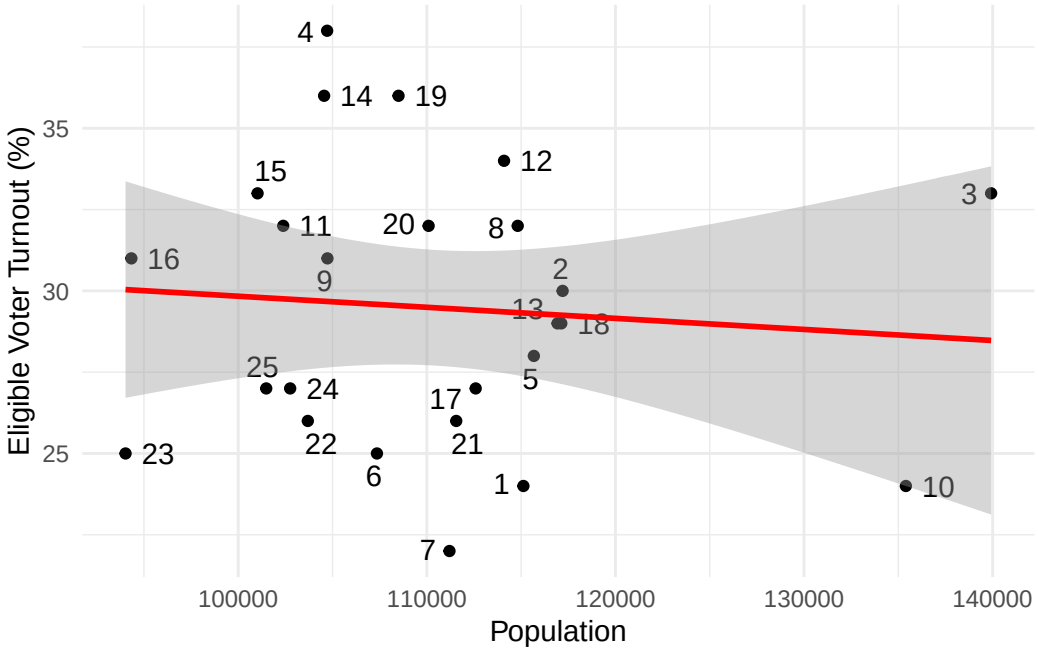


Figure 6: Correlation between Eligibile Voter Turnout and Ward's Population

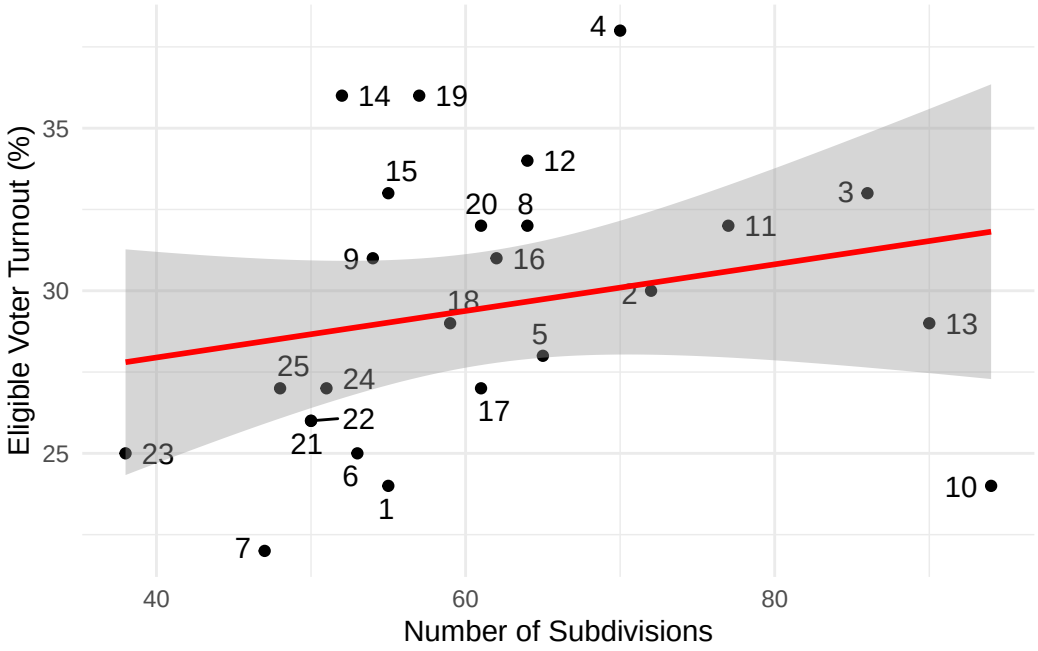


Figure 7: Correlation between Eligibile Voter Turnout and Ward's Number of Subdivisions

3 Model

The goal of our modelling strategy is twofold. Firstly,...

Here we briefly describe the Bayesian analysis model used to investigate... Background details and diagnostics are included in Appendix B.

3.1 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

$$y_i|\mu_i, \sigma \sim \text{Normal}(\mu_i, \sigma) \tag{1}$$
$$\mu_i = \alpha + \beta_i + \gamma_i \tag{2}$$
$$\alpha \sim \text{Normal}(0, 2.5) \tag{3}$$
$$\beta \sim \text{Normal}(0, 2.5) \tag{4}$$
$$\gamma \sim \text{Normal}(0, 2.5) \tag{5}$$
$$\sigma \sim \text{Exponential}(1) \tag{6}$$

We run the model in R (R Core Team 2023) using the `rstanarm` package of Goodrich et al. (2022). We use the default priors from `rstanarm`.

3.1.1 Model justification

We expect a positive relationship between the size of the wings and time spent aloft. In particular...

We can use maths by including latex between dollar signs, for instance θ.

4 Results

Our results are summarized in **?@tbl-modelresults**.

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Table 5: Socio-economic explanatory models of voter turnout based on education, employment and income

	Multiple Linear Regression	Poisson Regression
(Intercept)	31.28	11.03
	(10.01)	(0.02)
percent_uneducated	−0.11	0.00
	(0.25)	(0.00)
income	0.04	0.00
	(0.03)	(0.00)
unemployment_rate	−0.41	−0.08
	(0.65)	(0.00)
Num.Obs.	25	25
R2	0.354	
R2 Adj.	0.105	
Log.Lik.	−66.902	−7176.104
ELPD	−71.8	−7687.8
ELPD s.e.	4.8	1719.9
LOOIC	143.7	15 375.7
LOOIC s.e.	9.6	3439.7
WAIC	142.4	18 010.8
RMSE	3.33	3685.45

Table 6: Demographic explanatory models of voter turnout based on population and number of subdivisions

	Multiple Linear Regression	Poisson Regression
(Intercept)	39.80	9.52
	(9.49)	(0.01)
num_sub	0.17	0.01
	(0.08)	(0.00)
population	0.00	0.00
	(0.00)	(0.00)
Num.Obs.	25	25
R2	0.185	
R2 Adj.	−0.106	
Log.Lik.	−69.574	−9817.594
ELPD	−73.3	−10 373.2
ELPD s.e.	3.0	1962.9
LOOIC	146.5	20 746.4
LOOIC s.e.	6.0	3925.8
WAIC	146.1	23 902.6
RMSE	3.77	4268.57

Appendix

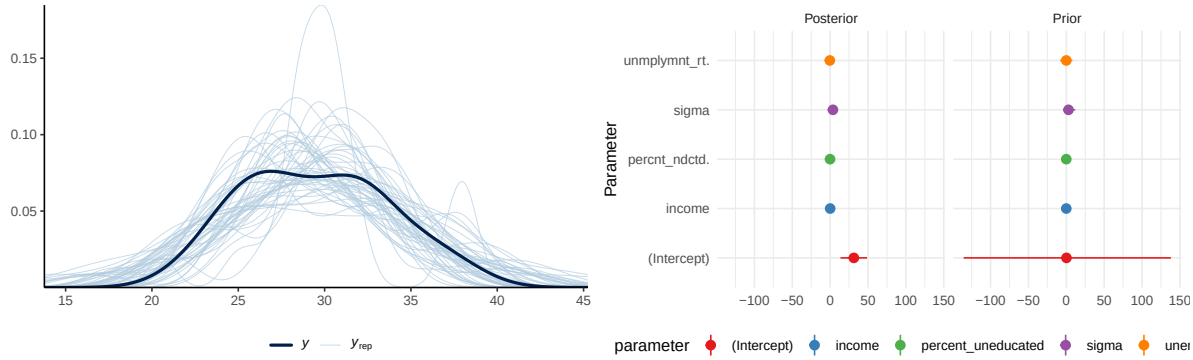
A Additional data details

B Model details

B.1 Posterior predictive check

In Figure 8a we implement a posterior predictive check. This shows...

In Figure 8b we compare the posterior with the prior. This shows...



(a) Posterior prediction check

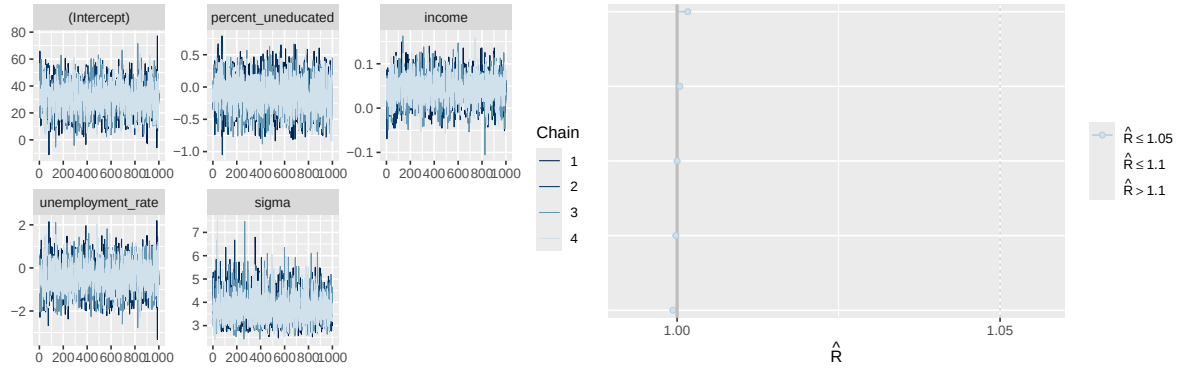
(b) Comparing the posterior with the prior

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

B.2 Diagnostics

Figure 9a is a trace plot. It shows... This suggests...

Figure 9b is a Rhat plot. It shows... This suggests...



(a) Trace plot

(b) Rhat plot

Figure 9: Checking the convergence of the MCMC algorithm

References

Goodrich, Ben, Jonah Gabry, Imad Ali, and Sam Brilleman. 2022. "Rstanarm: Bayesian Applied Regression Modeling via Stan." https://mc-stan.org/rstanarm/.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.