The Associations Between Mismanaged Plastic Waste and Per Capita GDP and Coastal Populations

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1 Introduction

1.1 Background Information

Plastic pollution is a severe and growing problem in the world, adversely affecting ecosystems and wildlife. According to Geyer and collaborators (2017), the world produced only two million tonnes of plastic. Since then, annual global plastic production has increased roughly 150-fold, reaching 313 million tonnes in 2010 (this upward trend has continued: approximately 460 million tonnes in 2019; Ritchie & Roser, 2018). Naturally, as plastic production has amplified across several decades, plastic waste generation has also increased. Increased plastic waste, by itself, is not the primary issue. The problem is that many (particularly, low-to-middle income) countries continue to rely on inefficient waste management systems which cannot cope with increasing waste generation (Ritchie & Roser, 2018). This has contributed to an increase in the amount of mismanaged plastic waste–plastic that is either inadequately disposed (stored in open or insecure landfills; high risk of polluting rivers and oceans) or littered by coastal populations (populations living within 50 kilometers of a coastline)–generated globally (Ritchie & Roser, 2018). Coastal populations are critical because their plastic waste is at a higher risk of leading to ocean debris (compared to sources further inland), but "mismanaged waste could eventually enter the ocean via inland waterways, wastewater outflows, and transport by wind or tides" (Ritchie & Roser, 2018).

1.2 Research Aims

How is a country's per capita GDP associated with its proportion of mismanaged plastic waste?

How is a country's coastal population proportion (Number of individuals living on/near coast / total population) associated with its proportion of mismanaged plastic waste?

1.3 Data Description and Key Variables

1.4 Hypotheses

1.5 Exploratory Data Analysis

2 Methodology

conduct a complete case analysis (first exclude non-countries, then exclude countries without full information - Kosovo, Timor (island; East Timor - sovereign, West Timor part of Indonesia) excluded for lack of population data) - response variable is created from mismanaged and total plastic waste - per capita GDP (based

on 2011 international rates) and proportion of country's coastal population to total population (reported by Gapminder) are covariates of interest

-> only consider 2010 since that's when plastic waste data is available -> create response variable: Per Capita Mismanaged Waste (Per Day) / Per Capita Waste (Per Day) -> create second covariate: Coastal Population / Total Population

-> tried to manually adjust total population for countries whose coastal population > total population, but found that the issue persisted for some countries - issues with data collection of coastal population (how is it collected?)

response variable: between [0, 1] beta regression! - not a GLM

- logit link

- Y ~ Beta(Alpha, Beta)

- logit(E(Y|X)) = X' beta

- log(Alpha / Beta) = X' beta

- Y = ratio of mismanaged to total plastic waste

- no error term

- interpretations: linear predictor of logit of conditional expectation

- why use logit link? - interpretability

- interactions -> no because interpreting quantitative-quantitative interactions is difficult, not aligned with objective

- assumptions for beta regression? - independence (only 2010 -> satisfied), linearity of predictors

Using mathematical notation, we can express our final model as

$$\log(T_i) = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \beta_5 x_{5i} + \beta_6 x_{6i} + \beta_7 x_{7i} + \beta_8 x_{8i} + \ldots + \beta_{30} x_{30i} + \epsilon_i$$

where i is the index for the patient (ranging from 1 to 21,180), T_i is the predicted survival time of ith patient with a history of smoking. In terms of the covariates, x_{1i} through x_{3i} indicate the ith patient's body mass index category, x_{4i} through x_{7i} indicate the ith patient's congestive heart failure severity, and x_{8i} through x_{30i} are the controlled patient demographic and medical factors.

3 Results

The regression coefficients were estimated using the `betareg()` function in R. Table 2 displays the coefficient estimates, as well as the corresponding 95% confidence intervals and p-values for the final model.

Table 1: Final Model Coefficients and 95% Confidence Intervals

	Coefficient	Lower Bound	Upper Bound	P-Value
(Intercept)	1.164	0.885	1.444	<0.01
Per Capita GDP	0.000	0.000	0.000	<0.01
Coastal Population Proportion	-0.332	-0.729	0.065	0.1015

Holding the proportion of a country's total population that lives within 50 kilometers of a coastline constant:

4 Discussion

4.1 Conclusions

4.2 Limitations and Future Directions

4.3 Summary

5 Appendices

6 References

1) Geyer et al., 2017: Production, use, and fate of all plastics ever made | Science Advances

2) Hannah Ritchie and Max Roser (2018) - "Plastic Pollution". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/plastic-pollution' [Online Resource]

https://github.com/rfordatascience/tidytuesday/tree/master/data/2019/2019-05-21