

Who Gets What: How Population and Income Shape Toronto's Budget Decisions*

Understanding the Impact of Demographics and Economic Factors on City Spending Across 25 Wards

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This study investigates how population density and average household income affect budget allocations across Toronto's 25 wards. Using data from the city's 2023-2032 Capital Budget Plan and 2021 Ward Profiles, we analyze spending patterns in key areas like health and safety, infrastructure, and community services. Our findings reveal that higher population densities do not guarantee proportionally greater investments in essential services, while wealthier wards often receive larger capital expenditures. These insights highlight potential disparities in resource distribution, emphasizing the need for more equitable urban budget planning to address diverse community needs.

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*Code and data are available at: <https://github.com/Aviral-03/Toronto-WardWide-Budget-Analysis>

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1 Introduction

2 Data

The raw data was sourced from the City of Toronto’s Open Data Portal using the `opendatatoronto` (Gelfand 2022) package. For the purpose of this analysis we used several data sets: **2023 Ward Profiles (25-Ward Model)** (Toronto 2024b), **Capital Budget and Plan Details from 2021-2024** (Toronto 2024c), **City Wards** (Toronto Open Data Portal 2024), and **Building Permits - Active Permits** (Toronto 2024a).

The data, provided in CSV formats, was cleaned and analyzed using R (R Core Team 2024) programming language. The `readxl` (Wickham and Bryan 2023) package was used for reading Excel files. Other R packages used which includes `tidyverse` (Wickham et al. 2019), `styler` (Müller and Walthert 2024), and `dplyr` (Wickham et al. 2023) for creating tables. The `ggplot2` (Wickham 2016) and `kableExtra` (Zhu 2024) were used for data visualization and table formatting. The `patchwork` (Pedersen 2024) package was used for combining multiple plots, and `sf` (Venables and Ripley 2002) for spatial data analysis. For models, we used `rstan` (`rstan?`) was used for fitting the model, and `modelsummary` (`modelsummary?`) for model summary tables. The `lintr` (`lintr?`) package was used for code linting. The `arrow` (`arrow?`) package was used for reading and writing Parquet files.

2.1 Measurement

Our research question and estimand analyse the relationship between key demographic and economic factors—specifically, population and average household income—and the budget allocation across various categories in Toronto’s 25 wards. Population is a critical demographic indicator, representing the number of residents in each ward, while average household income reflects economic well-being, influencing access to resources and quality of life (Schaeffer 2021). Therefore, these two variables of interest were chosen for the analysis. Our primary aim is to estimate the impact of these variables on budget allocations for these specific categories of interest, specifically Growth-Related expenditures, State of Good Repair, and Service Improvement and Enhancement.

Population density is expected to affect the demand for services and infrastructure, while average household income may shape how resources are distributed across wards, reflecting broader economic disparities. The estimand is the causal effect of these factors on the allocation of funds, and the estimator will quantify how shifts in population and income levels influence budgetary decisions. By understanding this relationship, we aim to offer insights into how demographic and economic variables drive municipal spending patterns in different categories across the city. In order to better analyze the trends and modelling the data, we will use the Capital Budget and Plan Details from 2021-2024 datasets, comparing total 10-year budget allocations across different wards and categories of interest.

2.2 Ward Profiles (25-Ward Model)

The 2021 Ward Profiles (Toronto 2024b), based on the 25-Ward model were provided by City Planning. These profiles included census data from the 2021, 2016, and 2011 Census of Population, covering demographic, social, and economic information for each ward in Toronto. These variables were collected through methods including online responses, mailed questionnaires, the Census Help Line, and enumerators (Statistics Canada Government of Canada 2023).

These questionnaires gathered information on various topics related to residents’ demographic characteristics, such as education, household income, number of dependents, employment status and etc. Participation in the survey is voluntary, and data is collected directly from residents, including their postal codes, which are used to determine their respective wards. To ensure privacy and confidentiality, the data is subsequently aggregated and anonymized (S. C. Government of Canada and Government of Canada 2023).

This data-set was included in this analysis to provide insights into the population and average household income for each ward, providing insights into the city’s socioeconomic landscape. 25-Ward model was used instead of the 44-Ward model as it was the most recent data available at the time of analysis and matched the Capital Budget data.

The data was stored in an Excel workbook with multiple tabs, but for this analysis, we used the first tab, `2021 Census One variable`, which contains data for all 25 wards (Ward 1, Ward

2, ..., Ward 25). After cleaning, the data was saved in CSV and Parquet formats, with the following columns:

- **ward_id**: unique identifier for each ward,
- **ward**: ward name,
- **population**: total population,
- **income**: average household income.

The ward names were manually entered into the cleaned data to match with **ward_id**. A sample of the data can be seen in Table 1.

Table 1: Sample of Cleaned Toronto Ward Profile Data

Ward ID	Ward Name	Population	Income
1	Etobicoke North	115120	95200
2	Etobicoke Centre	117200	146600
3	Etobicoke-Lakeshore	139920	127200
4	Parkdale-High Park	104715	127200
5	York South-Weston	115675	88700
6	York Centre	107355	107500

2.3 Capital Budget and Plan Details

Each year, the City of Toronto publishes the Capital Budget and Plan Details dataset (Toronto 2024c), which outlines a 10-year capital budget and plan. This dataset breaks down the capital budget across the city’s 25 wards, allocating funds for infrastructure projects, equipment purchases, and other fixed assets. This budget is developed through a collaborative process, where city staff prepare an initial draft, which is then reviewed by the Budget Committee. Input is solicited from Toronto residents and businesses, and subsequently, the Mayor presents the finalized budget proposal by February 1. City Council reviews and considers this budget within 30 days (Toronto 2024d).

For the purpose of this analysis we selected the year 2021-2024 to align with the 2022 municipal elections and the subsequent relevance to planning efforts. Furthermore, the city’s budgeting process underwent significant shifts after 2020 due to the impact of the COVID-19 pandemic, which altered spending priorities and resource allocation. Focusing on the 2021–2024 timeframe allows us to analyze the post-pandemic period, avoiding the uncertainties of the pandemic and ensuring the data remains consistent and reliable.

Each budget plan includes five primary categories under **State of Good Repair**, **Growth Related**, **Health and Safety**, **Service Improvement and Enhancement**, and **Legislated**.

These categories define the main areas where capital expenditures are directed. For this analysis, however, we will focus on these three variables of interest: **State of Good Repair**, **Growth Related**, and **Service Improvement and Enhancement**.

These categories were selected because they represent critical areas of investment that directly impact the quality of life and well-being of Toronto residents. **State of Good Repair** focuses on maintaining and preserving existing infrastructure, **Growth Related** addresses the expansion and development of new infrastructure, and **Service Improvement and Enhancement** aims to enhance public services and amenities. By analyzing budget allocations in these categories, we can gain valuable insights into the city’s spending priorities and identify opportunities for more effective and equitable resource distribution. While also identifying potential disparities in funding across various wards of the city.

Raw data includes key columns such as **Project Name**, yearly budget allocations for each year, **Ward Number**, **Ward**, **Category**, and **Total 10 Year** (Sum of Year 1 to 10), where the budget is in thousands of dollars (e.g., 10 = \$10,000). Table 2 shows a sample of the cleaned data along with our variables of interest:

- **Ward ID**
- **Ward Name**
- **Category of the Capital Budget**
- **Total 10-year capital budget** allocated to each ward

Rows with **CW** (city-wide budget) were removed since they were applicable to all wards.

Table 2: Sample of Cleaned Toronto Capital Budget Data

Ward ID	Ward Name	Category	Total 10-Year Budget (in 000s)
1	Etobicoke North	Growth Related	37873.0
1	Etobicoke North	Service Improvement and Enhancement	6361.0
2	Etobicoke Centre	Growth Related	69025.0
2	Etobicoke Centre	Service Improvement and Enhancement	20116.0
2	Etobicoke Centre	State of Good Repair	5112.0
3	Etobicoke-Lakeshore	Growth Related	85358.9

2.4 City Wards

The City Wards dataset (Toronto Open Data Portal 2024), published by the City Clerk’s Office and last updated on July 22, 2024, contains geographical information about each ward,

including the ward ID, ward name, and ward boundary. These ward boundaries were decided as a part of Bill 5, **Better Local Government Act** in 2018, reducing the number of wards from 47 to 25 (Toronto Open Data Portal 2024).

This dataset, effective January 1, 2024, was used to map the **ward_id** to the ward name in the cleaned data. Key columns include:

- **ward_id**: unique identifier for each ward,
- **ward**: ward name,
- **ward_boundary**: geographical boundary of the ward.

The ward names were mapped to the **ward_id** and integrated with the Ward Profiles Section 2.2 and Capital Budget data sets Section 2.3 to create the final data set for analysis. This dataset was not used directly in the analysis but was essential for mapping the ward names to the ward IDs in the cleaned data.

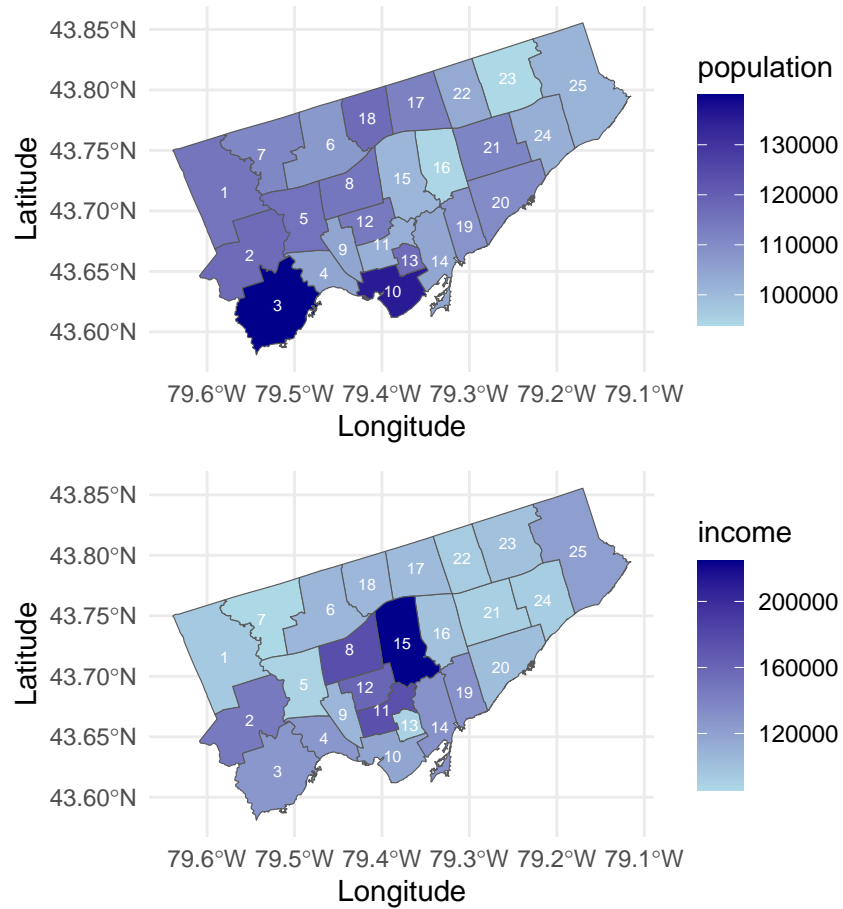


Figure 1: Map of Toronto highlighting the population and income densities by ward

2.5 Building Permits - Active Permits

The *Building Permits - Active Permits* dataset (Toronto 2024a), published by the City Planning Division and last updated on November 28, 2024, serves as a comprehensive record of active building permits in Toronto. A building permit is a municipally issued document, mandated by the Building Code Act and enforced by the City of Toronto, regulating the construction or demolition of physical structures (Toronto 2024a).

The process of obtaining a building permit involves submitting an application to the City of Toronto, including necessary drawings, documents, and other forms based on the permit type. The Building Division reviews the application, and a Toronto Building Inspector ensures compliance with the Ontario Building Code, Zoning By-law, and other applicable regulations. Once approved, the permit is issued, allowing the applicant to commence construction or demolition.

Table 3 outlines detailed information about active building permits in Toronto, including key features such as **Permit Number**, **Permit Type**, **Structure Type**, **Status**, and more.

Table 3: Sample of the raw building permits data

ID	Permit Type	Structure Type	Work	Postal Code	Status
1	Non-Residential Building Permit	Office	Addition to Existing Building	M2R	Permit Issued
2	Residential Building Permit	SFD - Semi-Detached	Addition to Existing Building	M4L	Inspection
3	Residential Building Permit	Multiple Unit Building	Alteration to Existing Building	M6R	Inspection
4	Residential Building Permit	HVAC Alt. Boiler/Furn Rplmt. or A/C	HVAC	M6K	Inspection
5	Mechanical(MS)	HVAC Alt. add on Sys. or Ductwork Alt.	Install/Alter HVAC - only	M6H	Inspection
6	Mechanical(MS)	Office	Install/Alter HVAC - only	M5C	Inspection

We selected this data-set to evaluate how budget allocations correlate with the number of building permits issued in each ward. The number of permits serves as a proxy for construction activity and development, highlighting the demand for infrastructure investment and capital expenditures. By examining the relationship between building permits and budget allocations, we can gain valuable insights into how construction activity influences resource distribution across the city’s wards.

From the raw data, we selected key variables of interest: **Postal Code**, **Status**, and **Work**. The **Postal Code** was used to map building permits to their respective wards, while **Status** and **Work** were utilized to filter permits based on their current state and type of work. Table 5 lists 45 unique statuses assigned to each submitted permit. For this analysis, we focused on permits with the following statuses: **Approved**, **Application Accepted**, **Issuance Pending**, **Ready for Issuance**, **Permit Issued**, and **Permit Issued/Close File**. These statuses indicate that the permit has been approved and that construction or demolition is either underway or completed.

To ensure we analyzed only construction-related permits, we filtered out entries where **Work** did not have the value **New Building**. The cleaned data was then saved in CSV and Parquet formats with the following columns:

- **ward_id**: Unique identifier for each ward.
- **total_building_permits**: Total number of building permits issued in each ward.

Figure 2 illustrates the total number of building permits by ward, providing valuable insights into construction activity and development patterns across Toronto's wards.

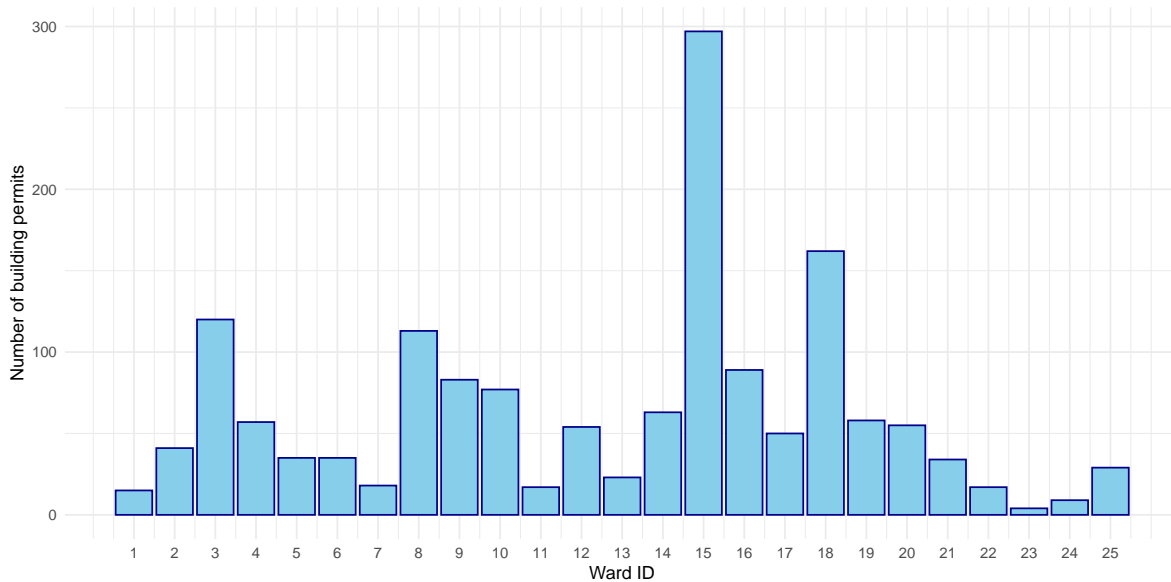


Figure 2: Total number of building permits by Ward

2.6 Trends in Budget Allocations (2021-2024)

2.7 Model

The purpose of this paper is to investigate the relationship between population density, average household income, and budget allocations across Toronto’s 25 wards, and their potential impact on the economic well-being of each ward, as represented by the `total_building_permits` issued. To achieve this, we developed a causal model that examines how population and income influence the allocation of funds in key budget categories: `Growth Related`, `State of Good Repair`, and `Service Improvement and Enhancement`.

We employed multilevel modeling to estimate the effect of these variables on the number of building permits issued in each ward. Here we briefly describe a Bayesian Poisson regression model, which incorporates varying intercepts by grouping the effect by ward account. This approach allows us to capture the nuanced effects of demographic and economic factors on infrastructure development and resource distribution. Background details and diagnostics are included in Appendix 4.2.

2.7.1 Model set-up

The model was specified as follows:

$$\begin{aligned} \text{Building Permits}_i &\sim \text{Poisson}(\lambda_i) \\ \log(\lambda_i) &= \beta_0 + \beta_1 \times \text{Population}_i + \beta_2 \times \text{Income}_i + \beta_3 \times \text{Budget}_i + \alpha_{\text{ward}[i]} \\ \beta_0 &\sim \text{Normal}(0, 2.5) \\ \beta_1 &\sim \text{Normal}(0, 2.5) \\ \beta_2 &\sim \text{Normal}(0, 2.5) \\ \beta_3 &\sim \text{Normal}(0, 2.5) \\ \alpha_{\text{ward}} &\sim \text{Normal}(0, \sigma_{\text{ward}}) \end{aligned}$$

In the above model:

- $\text{Building Permits}_i$ represents the number of building permits issued in ward i ,
- λ_i is the expected count of permits for ward i .
- $\log(\lambda_i)$ is the linear predictor, which includes:
 - β_0 : Intercept
 - β_1 : Effect of `population`
 - β_2 : Effect of `average_household_income`
 - β_3 : Effect of `budget_allocation`

- $\alpha_{\text{ward}[i]}$: Random effect for each ward (captures unobserved heterogeneity between wards).

- Priors for β_0 , β_1 , β_2 , and β_3 are $\text{Normal}(0, 2.5)$, allowing for flexibility.

The model was fitted using the `stan_glm` function from the `rstanarm` package (Brilleman et al. 2018) in R (R Core Team 2024). The prior distributions for the coefficients were set to normal distributions with a mean of 0 and a standard deviation of 2.5. The model also included a prior for the intercept, which was set to a normal distribution with a mean of 0 and a standard deviation of 2.5. The varying intercepts for each ward were modeled using a normal distribution with a mean of 0 and a standard deviation of σ_{ward} .

2.7.2 Model justification

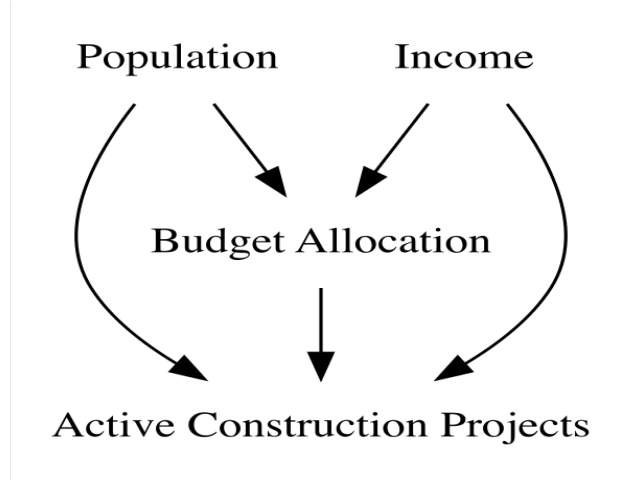


Figure 3: Causal model for the relationship between population, income, and budget allocations

2.8 Results

In this section, we visualize the relationships between population density, average household income, budget allocations with total number of building permits across Toronto’s 25 wards.

Additionally, we present our model results, highlighting how these variables influence the number of building permits issued in each ward.

2.8.1 Relationship between Population, Average Household Income, and Budget Allocations

Our budget data spans three categories—Growth Related, State of Good Repair, and Service Improvement and Enhancement—for the years 2021-2024. As observed in Section 2.6, there has been a steady increase in budget allocations across these categories. To better understand the relationship between these budget categories and our variables of interest, we calculate the average budget allocation for each category across the years. The results are presented in Table 4.

Table 4: Average 10-year budget allocations by category (2021-24)

Ward ID	Ward Name	Growth Related	State of Good Repair	Service Improvement and Enhancement
1	Etobicoke North	46497.25	2565.643	7279.627
2	Etobicoke Centre	86651.25	5546.250	126011.750
3	Etobicoke-Lakeshore	112789.98	9572.525	205245.100
4	Parkdale-High Park	171717.25	8373.225	7211.932
5	York South-Weston	73226.12	12362.250	11403.250
6	York Centre	31927.25	10725.475	3865.750

2.9 Relationship between Average Household Income & Population with Budget Allocation for Growth Related Projects

2.10 Relationship between Average Household Income & Population with Budget Allocation for State of Good Repair Projects

2.10.1 Relationship between Average Household Income & Population with Budget Allocation for Service Improvement and Enhancement Projects

3 Discussion

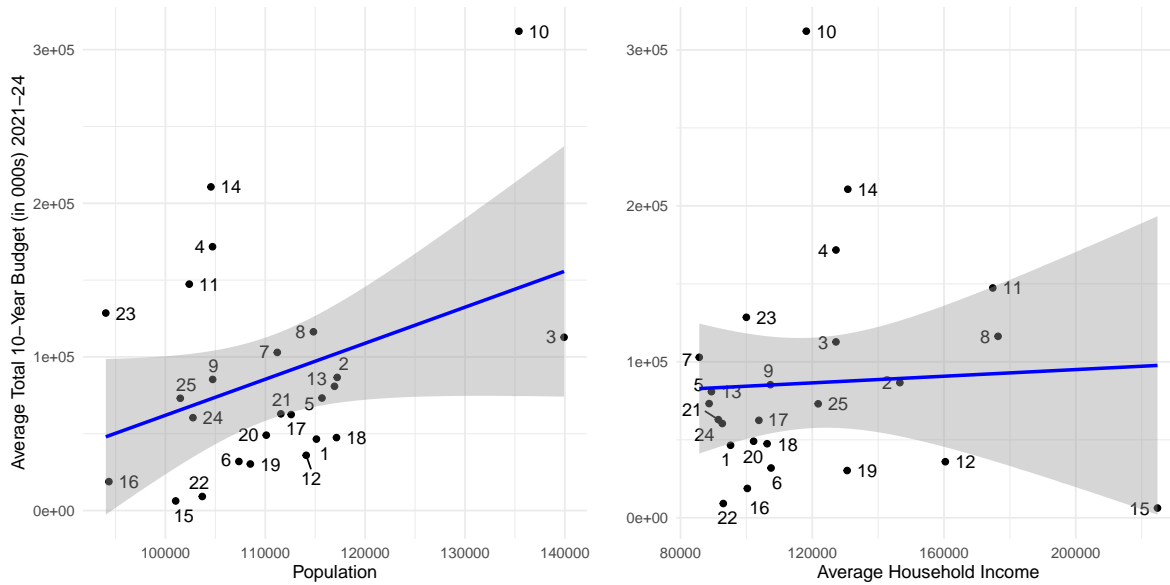


Figure 4: Growth Related Budget by Ward

4 Appendix

4.1 Data Tables

4.1.1 Building Permits Status

Table 5: Building permit statuses

STATUS

Permit Issued
 Inspection
 Application Withdrawn
 Revised
 Pending Cancellation
 Application Received
 Revision Issued
 Order Complied
 Revocation Pending
 Rescheduled
 Examiner's Notice Sent
 Issuance Pending

Inspection Request to Cancel
Under Review
Plan Review Complete

Not Accepted
Permit Issued/Close File
Ready for Issuance
Work Suspended
Abandoned

File Closed
VIOLATION
Work Not Started
Not Started
Order Issued

Response Received
Refusal Notice
Forwarded for Issuance
Application On Hold
Application Acceptable

Follow-up Required
Consultation Completed
Extension Granted
Request Received
Active

Deficiency Notice Issued
Refused
Approved
Agreement in Progress
NA

Open
Application Accepted
Permit Revoked
Forward to Inspector
Revoked

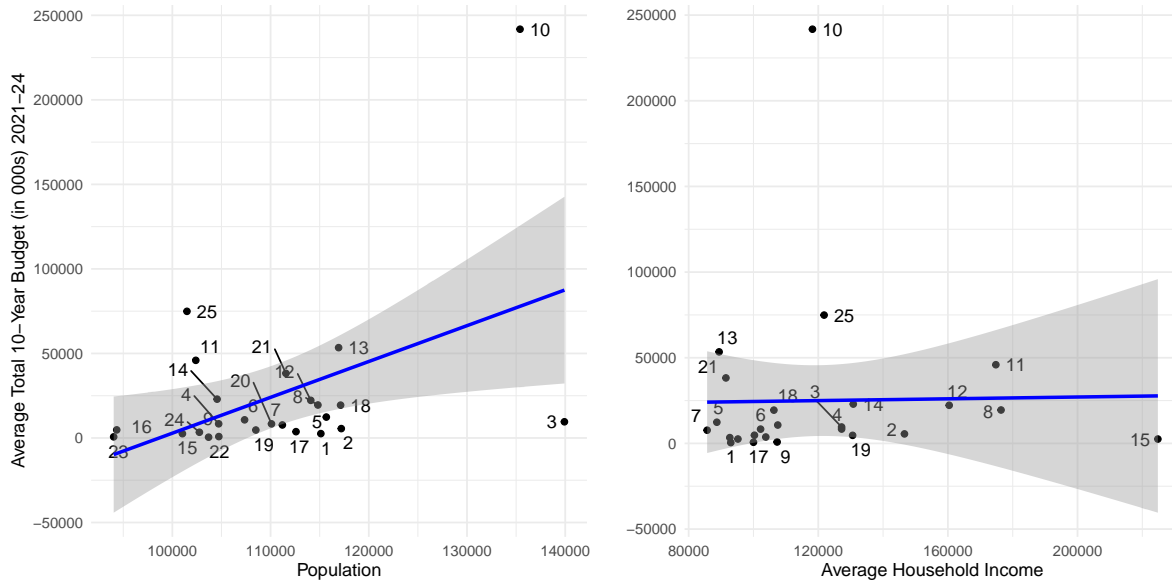
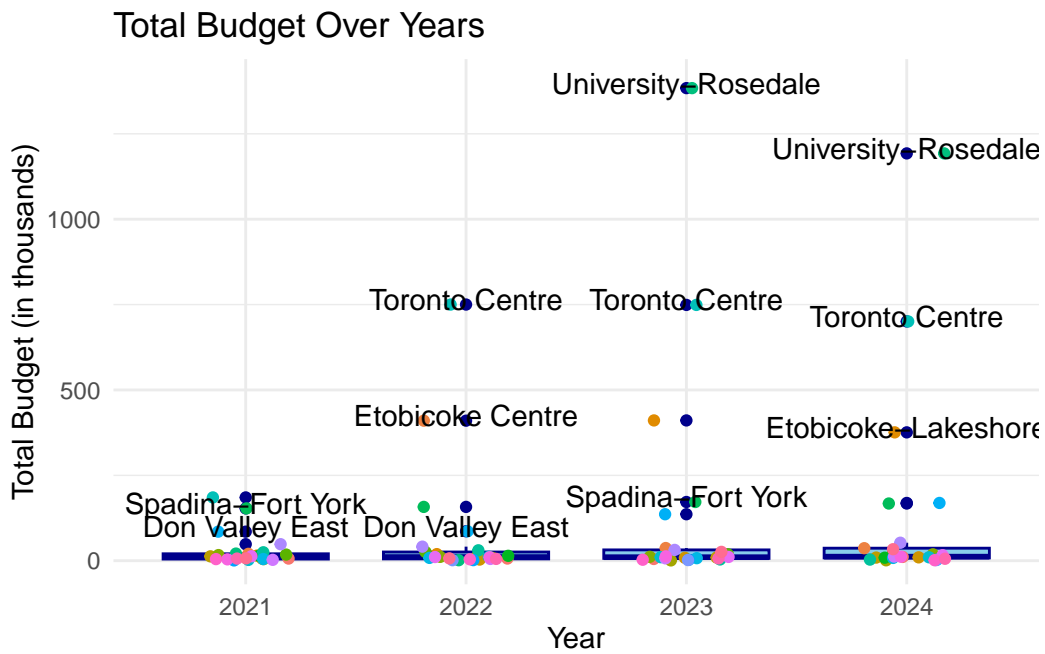


Figure 5: State of Good Repair Budget by Ward

4.2 Model Details



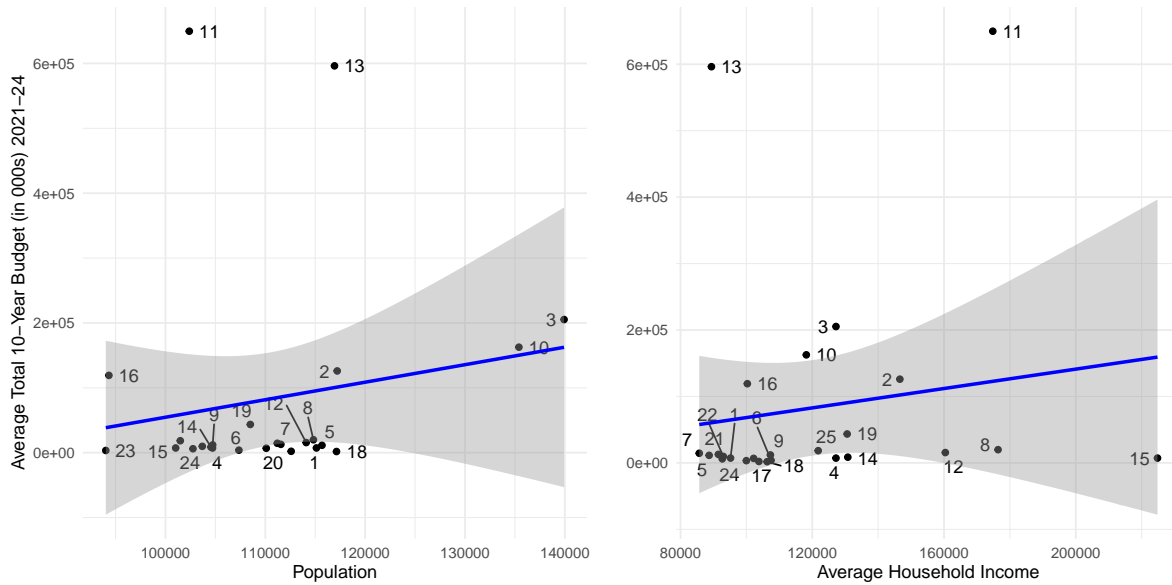
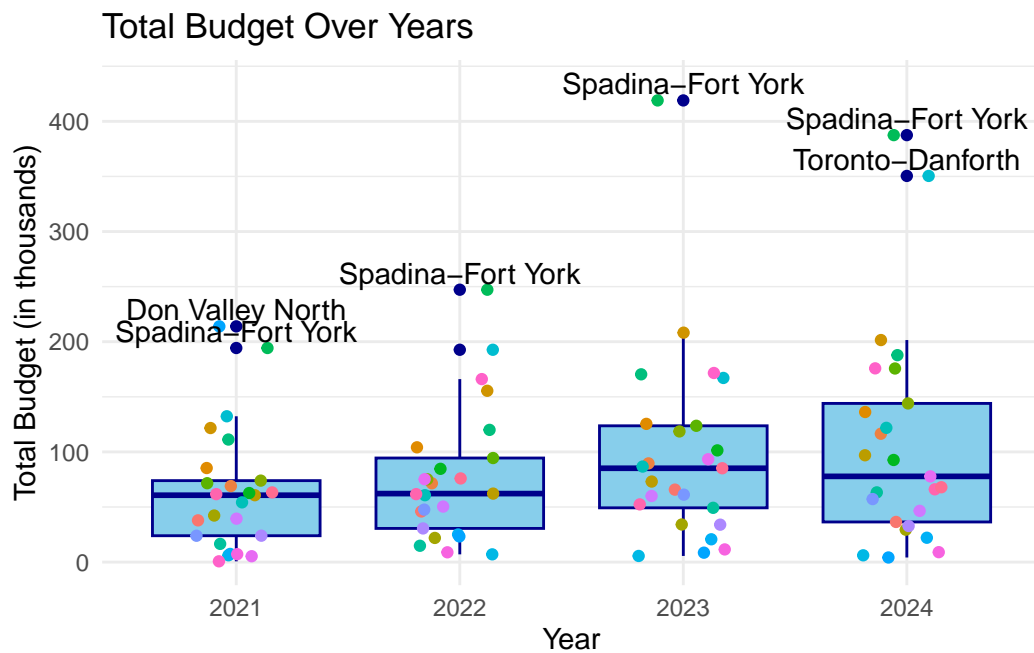
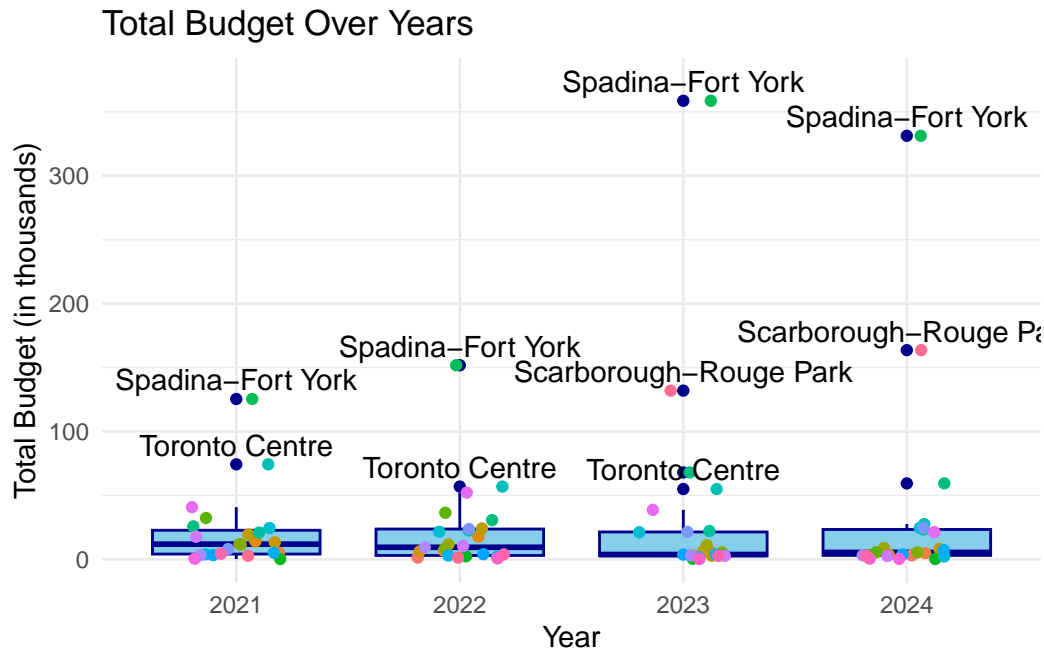


Figure 6: Service Improvement and Enhancement Budget by Ward





References

- Brilleman, SL, MJ Crowther, M Moreno-Betancur, J Bueros Novik, and R Wolfe. 2018. “Joint Longitudinal and Time-to-Event Models via Stan.” https://github.com/stan-dev/stancon_talks/.
- Gelfand, Sharla. 2022. *Opendatatoronto: Access the City of Toronto Open Data Portal*. <https://CRAN.R-project.org/package=opendatatoronto>.
- Government of Canada, S. C., and Statistics Canada Government of Canada. 2023. “National Household Survey (NHS).” Surveys; Statistical Programs. www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5178.
- Government of Canada, Statistics Canada. 2023. “National Household Survey (NHS).” Surveys; Statistical Programs. www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5178.
- Müller, Kirill, and Lorenz Walthert. 2024. *Styler: Non-Invasive Pretty Printing of r Code*. <https://CRAN.R-project.org/package=styler>.
- Pedersen, Thomas Lin. 2024. *Patchwork: The Composer of Plots*. <https://CRAN.R-project.org/package=patchwork>.
- R Core Team. 2024. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.
- Schaeffer, Katherine. 2021. “‘What’s the Difference Between Income and Wealth?’ And Other Common Questions about Economic Concepts.” *Decoded*. Pew Research Center. <https://www.pewresearch.org/decoded/2021/07/23/whats-the-difference-between-income-and-wealth-and-other-common-questions-about-economic-concepts/>.

- Toronto, City of. 2024a. “Building Permits - Active Permits.” Data Set. City of Toronto Open Data Portal. <https://open.toronto.ca/dataset/building-permits-active-permits/>.
- . 2024b. “Ward Profiles (25-Ward Model).” Data Set. City of Toronto Open Data Portal. open.toronto.ca/dataset/ward-profiles-25-ward-model/.
- . 2024c. “Budget - Capital Budget Plan by Ward (10-Yr Approved).” Data Set. City of Toronto Open Data Portal. open.toronto.ca/dataset/budget-capital-budget-plan-by-ward-10-yr-approved/.
- . 2024d. “2024 City Budget.” *City of Toronto*, May. www.toronto.ca/city-government/budget-finances/city-budget/.
- Toronto Open Data Portal, City of. 2024. “Open Data Dataset.” [open.toronto.ca.open.toronto.ca/dataset/city-wards/](https://open.toronto.ca/open.toronto.ca/dataset/city-wards/).
- Venables, W. N., and B. D. Ripley. 2002. *Modern Applied Statistics with s*. Fourth. New York: Springer. <https://www.stats.ox.ac.uk/pub/MASS4/>.
- Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <https://ggplot2.tidyverse.org>.
- Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D’Agostino McGowan, Romain François, Garrett Golemund, et al. 2019. “Welcome to the tidyverse.” *Journal of Open Source Software* 4 (43): 1686. <https://doi.org/10.21105/joss.01686>.
- Wickham, Hadley, and Jennifer Bryan. 2023. *Readxl: Read Excel Files*. <https://CRAN.R-project.org/package=readxl>.
- Wickham, Hadley, Romain François, Lionel Henry, Kirill Müller, and Davis Vaughan. 2023. *Dplyr: A Grammar of Data Manipulation*. <https://CRAN.R-project.org/package=dplyr>.
- Zhu, Hao. 2024. *kableExtra: Construct Complex Table with ‘Kable’ and Pipe Syntax*. <https://CRAN.R-project.org/package=kableExtra>.