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

Aviral Bhardwaj

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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

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 Captial 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

Table 2: Sample of Cleaned Toronto Capital Budget Data

Ward ID	Ward Name	Category	Total 10-Year Budget (in 000s)
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.

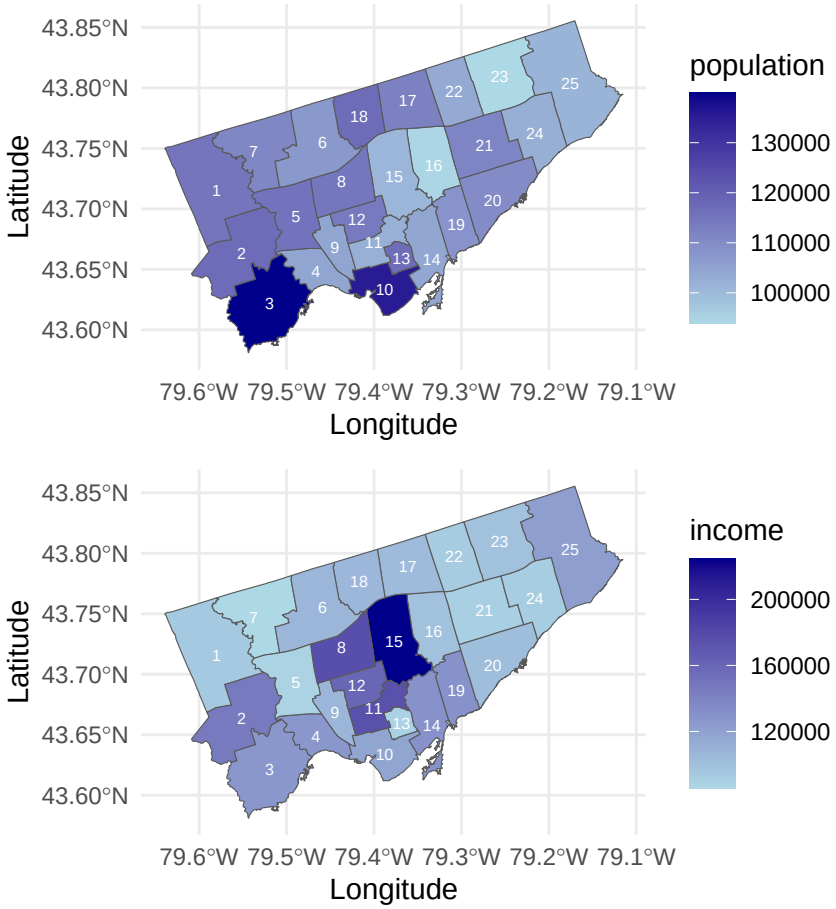


Figure 1: Map of Toronto highlighting the population and income densities by ward

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 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.

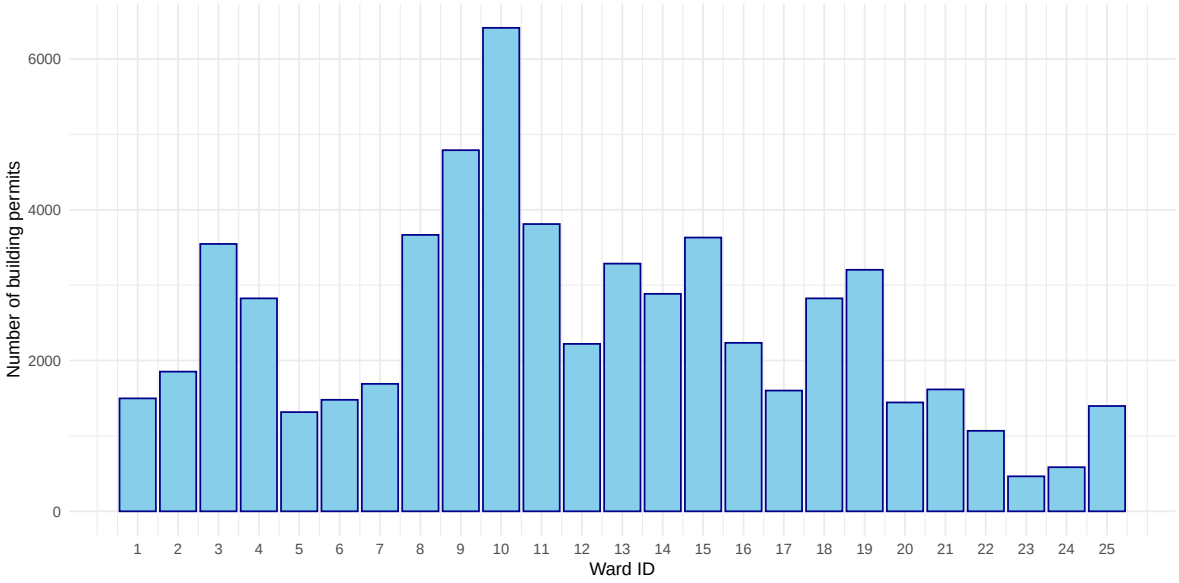
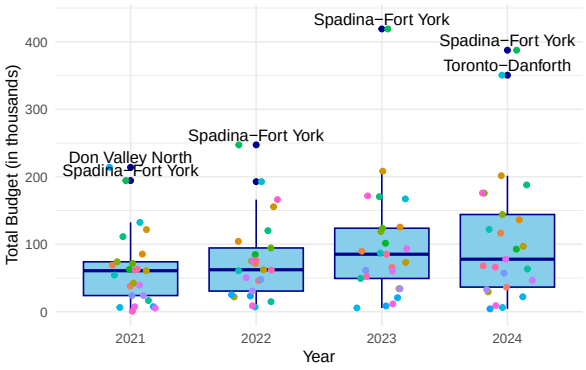


Figure 2: Total number of building permits by Ward

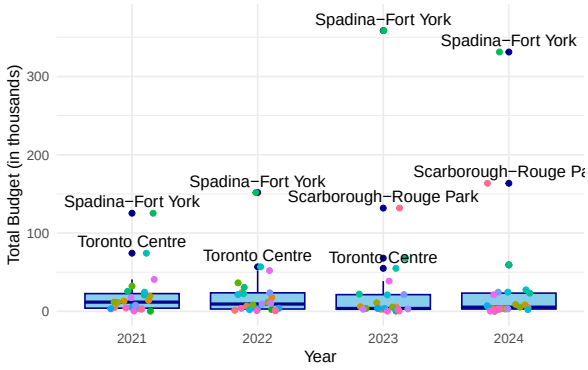
2.6 Trends in Budget Allocations (2021-2024)

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

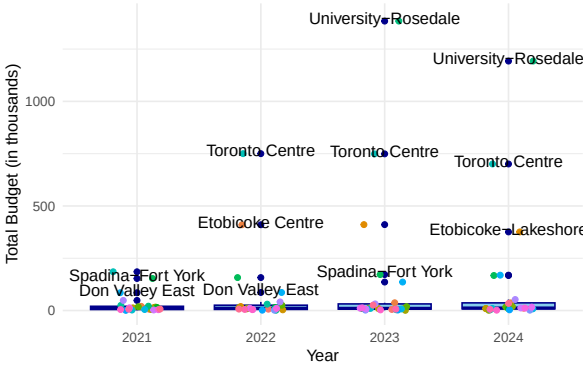
Our budget data spans three categories—`Growth Related`, `State of Good Repair`, and `Service Improvement and Enhancement`—for the years 2021-2024. As observed in Section 2.6, there has been a steady increase in budget allocations across these categories. To better understand the relationship between 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.



(a) Growth Related



(b) State of Good Repair



(c) Service Improvement and Enhancement

Figure 3: Trends in budget allocations (2021-2024) by category

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

2.7.1 Relationship between Average Household Income & Population with Budget Allocation for Growth Related Projects and State of Good Repair Projects

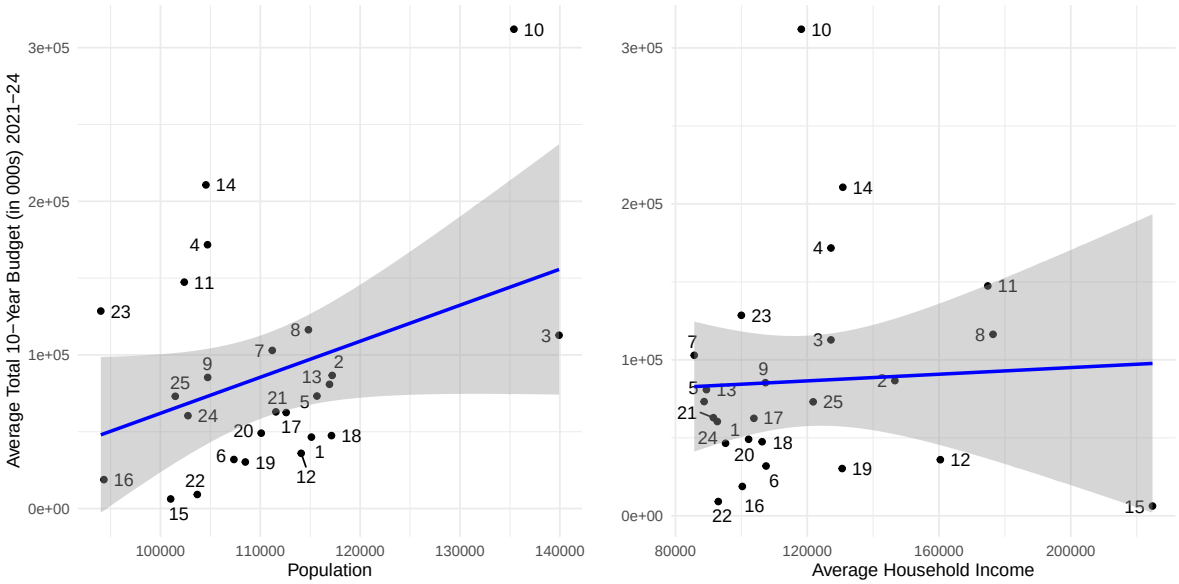


Figure 4: Growth Related Budget by Ward

Figure 4 illustrates the relationship between average household income, population, and the total 10-year budget allocation for Growth-Related projects. The linear regression line for average household income remains relatively flat, hovering around $100,000. This suggests that budget allocations for Growth-Related projects are not significantly influenced by income levels, indicating a more uniform distribution of funds across wards regardless of household income. A similar lack of correlation is observed in Figure 5, where budget allocations for State of Good Repair projects also show minimal dependence on average household income.

In contrast, the linear regression line for population shows a positive correlation with budget allocation for Growth-Related projects. Wards with higher population densities—such as Ward 10 (Spadina-Fort York), Ward 13 (Toronto Centre), Ward 5 (York South-Weston), and Ward 2 (Etobicoke North)—receive a larger share of the Growth-Related budget. This indicates that population density plays a critical role in determining funding levels for these projects, with more populous wards benefiting from increased allocations. A similar trend is observed in the budget distribution for State of Good Repair projects, where wards with higher population densities receive a proportionally larger share of the funds.

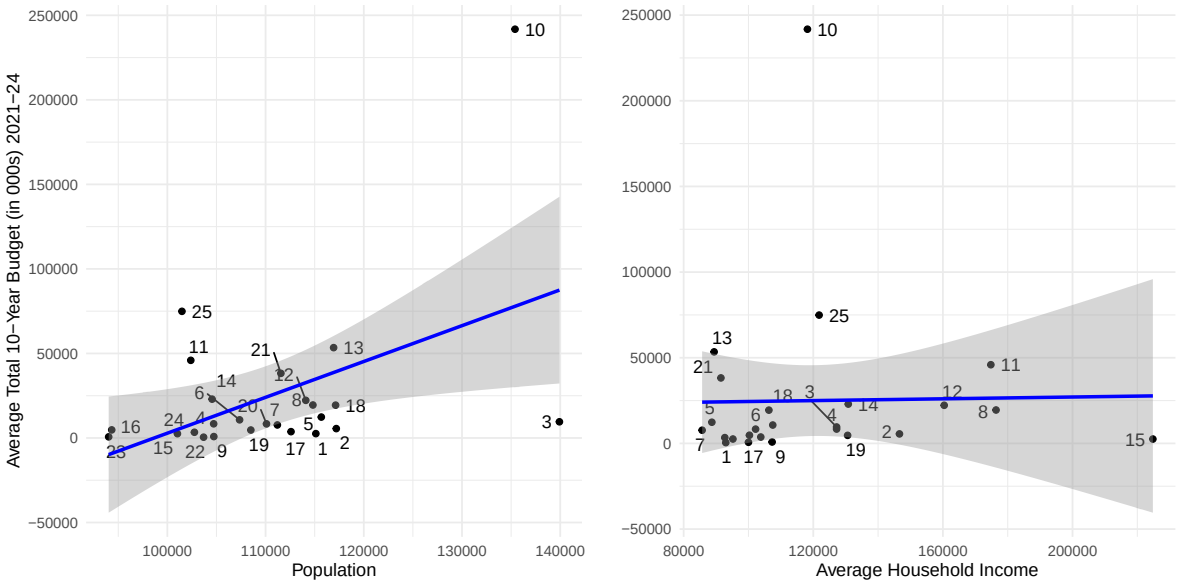


Figure 5: State of Good Repair Budget by Ward

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

Figure 6 illustrates the relationship between average household income, population, and the total 10-year budget allocation for Service Improvement and Enhancement projects. These projects aim to enhance the quality of services provided to residents and improve the overall infrastructure of the city (Toronto 2018).

Unlike Growth-Related and State of Good Repair projects, the linear regression lines for average household income and population shows a positive correlation with budget allocation for Service Improvement and Enhancement projects. Wards with higher average household incomes, such as Ward 11 (University-Rosedale) and Ward 13 (Toronto Centre), receive a larger share of the budget allocation for these projects. This suggests that higher-income areas are prioritized for service improvements and infrastructure enhancements, reflecting a targeted approach to resource allocation based on income levels.

Other wards like Ward 3 (Etobicoke-Lakeshore) and Ward 10 (Spadina-Fort York), which have high population densities, also received significant budget allocations, suggesting that these areas are priorities for service improvements and infrastructure enhancement.

Despite these outliers, the majority of wards received similar budget allocations for Service Improvement and Enhancement projects, underscoring a city-wide strategy to enhance services uniformly for all residents.

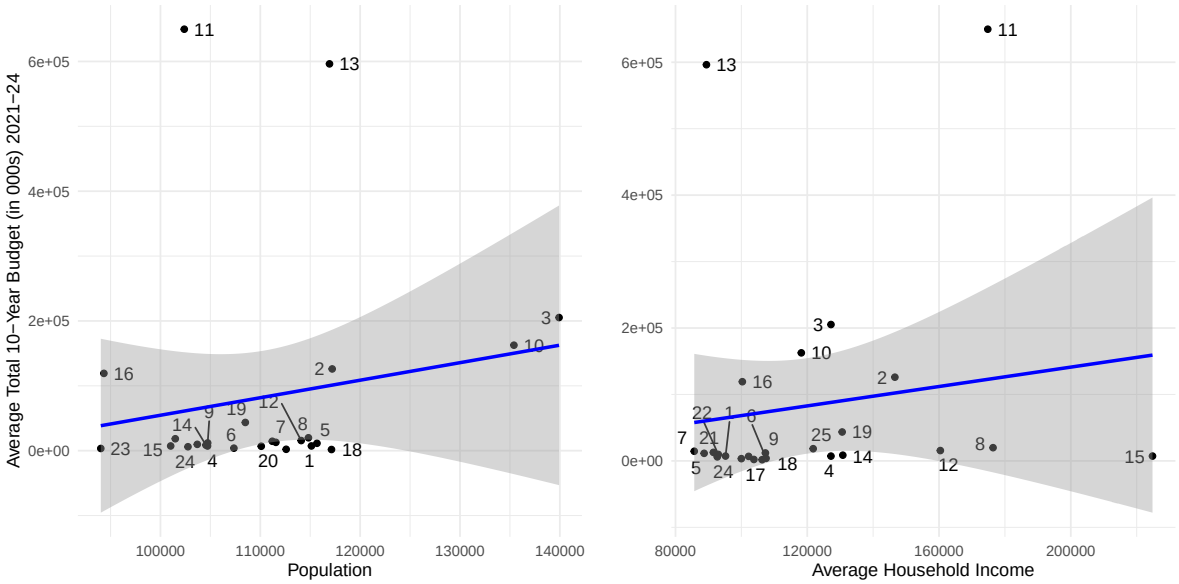


Figure 6: Service Improvement and Enhancement Budget by Ward

3 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 will first plot the data to visualize the relationships between these variables and the number of building permits issued in each ward independently. Then we will fit a Bayesian regression model with varying intercepts to estimate the effect of these variables on the number of building permits issued in each ward.

3.1 Model set-up

The particular model we used is Bayesian multiple linear regression model with varying intercepts. The model includes the following variables:

$$
\begin{aligned}
y_i|\mu_i, \sigma &\sim \text{Normal}(\mu_i, \sigma) \\
\mu_i &= \beta_0 + \beta_1 x_{\text{population}} + \beta_2 x_{\text{income}} + \beta_3 x_{\text{budget}} + \gamma_i \\
\beta_0 &\sim \text{Normal}(0, 2.5) \\
\beta_1 &\sim \text{Normal}(0, 2.5) \\
\beta_2 &\sim \text{Normal}(0, 2.5) \\
\beta_3 &\sim \text{Normal}(0, 2.5) \\
\gamma_i &\sim \text{Normal}(0, 2.5) \\
\sigma &\sim \text{Exponential}(1)
\end{aligned}
$$

In the above model:

- μ_i is the expected number of building permits issued in ward i.
- β_0 is the intercept, representing the expected number of building permits issued in a ward with average values for all other variables.
- β_1 is the coefficient for the predicted change in the number of building permits issued in a ward given a one unit increase in the population density of the ward.
- β_2 is the coefficient for the predicted change in the number of building permits issued in a ward given a one unit increase in the average household income of the ward.
- β_3 is the coefficient for the predicted change in the number of building permits issued in a ward given a one unit increase in the total budget allocation across three categories: Growth Related, State of Good Repair, and Service Improvement and Enhancement.

The model also includes a varying intercept γ_i for each ward, accounting for the unobserved heterogeneity between wards. The varying intercepts allow the model to capture the unique characteristics of each ward that may influence the number of building permits issued.

The model was fitted using the `stan_glmer` 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 standard deviation of the likelihood was set to an exponential distribution with a rate parameter of 1.

3.2 Model justification

The above factors were choosen as they are known to influence the number of building permits issued in each ward. Population density and average household income are key demographic and economic indicators that can impact construction activity and development. Budget allocations for Growth-Related, State of Good Repair, and Service Improvement and Enhancement

projects are critical determinants of infrastructure development and resource distribution. By incorporating these variables into the model, we can assess their individual and combined effects on the number of building permits issued in each ward.

A priori, we expect that population density and average household income will have a positive effect on the number of building permits issued, reflecting the demand for construction and development in densely populated and affluent areas. Similarly, we anticipate that budget allocations for Growth-Related, State of Good Repair, and Service Improvement and Enhancement projects will positively influence the number of building permits, reflecting the city's investment in infrastructure development and maintenance.

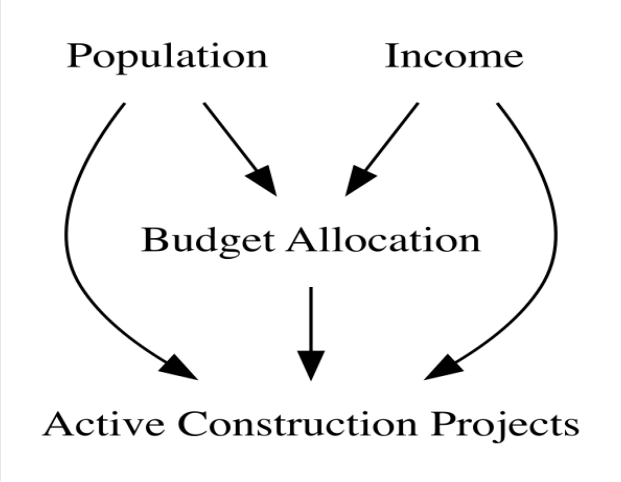
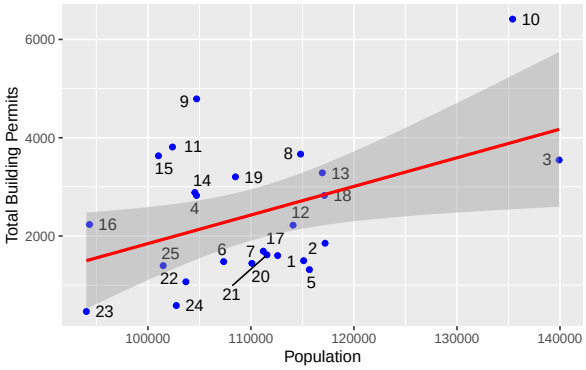


Figure 7: Causal model for the relationship between population, income, and budget allocations

4 Results

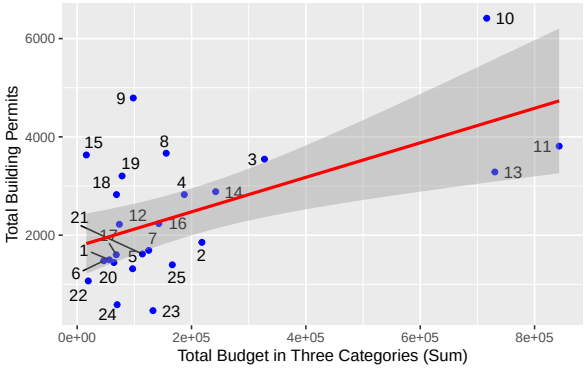
In this section, we visualize the relationships between population density, average household income, budget allocations with total number of building permits across Toronto's 25 wards. Additionally, we present our model results, highlighting how these variables influence the number of building permits issued in each ward.

4.1 Relationship between Building Permits and Population, Income, and Budget Allocations



(a) Population

(b) Average Household Income



(c) Total Budget in Three Categories

Figure 8: Relationship between Variables and Total Building Permits

We now explore the results of independent comparisons between the outcome variable (total number of building permits in Toronto's 25 wards) and the predictor variables (population density, average household income, and budget allocations for Growth-Related, State of Good Repair, and Service Improvement and Enhancement projects). As shown in Figure 8, most predictor variables exhibit relatively flat linear regression lines, indicating a weak relationship with the total number of building permits.

For example, the relationship between population density and building permits is notably flat, suggesting that population density has minimal influence on construction activity and development across the city's wards—an unexpected result. A similar trend is observed for Growth-Related and State of Good Repair budget allocations, where flat regression lines suggest a weak relationship. This appears contradictory to earlier findings, where higher population density corresponded to increased budget allocations for these categories, which are typically associated with infrastructure development and maintenance. The same weak correlation is

seen for Service Improvement and Enhancement budget allocations, as indicated by the flat regression line.

In contrast, the relationship between average household income and building permits shows a strong positive correlation. Higher-income areas tend to experience more construction activity and development. For instance, Ward 15 (Don Valley West) has the highest number of building permits, aligning with its high average household income. This suggests that higher-income areas are more likely to see increased construction and development, highlighting a clear link between income levels and building permits.

4.2 Model Results

5 Discussion

6 Weaknesses and Limitations

There are number of limitations that neeeds to be addressed in reagrds to the analysis. As we discussed in section Section 2, the data used in this analysis is based on publicly available datasets from the City of Toronto. While these datasets provide valuable insights into the city's demographics, budget allocations, and building permits, they may not capture the full complexity of the city's infrastructure development and resource distribution. For example, the building permits dataset only includes active permits, which may not fully represent the scope of construction activity in Toronto. Additionally, the budget allocations dataset may not capture all infrastructure projects and expenditures, leading to potential gaps in the analysis.

Additionally, as shown in Section 8, that there are 45 unique statuses assigned to each submitted permit. For this analysis, we just focused on one subset of these statuses. This may not fully capture the complexity of the building permit process and the various stages of construction and development in Toronto. Future analyses could explore additional permit statuses to gain a more comprehensive understanding of construction activity in the city.

One limitation of this study is the lack of detailed data on specific projects within each budget category, which could provide further insights into why certain wards receive more or less funding. Additionally, while this analysis focused on population density and average household income, other factors like infrastructure needs, community priorities, and political considerations likely play a role in budget decisions. Future research should explore these variables to build a more complete picture of how municipal budgets are allocated.

A potential limitation is regard ot the model. We assumed that the relationship between population density, average household income, and budget allocations is linear, which may not fully capture the complexity of these relationships. We also assumed independence of each ward, which may not hold true in practice due to shared resources, infrastructure projects, and other factors that could influence building permit issuance. Future research could explore

more sophisticated modeling techniques to account for these dependencies and non-linear relationships.

7 Future Work

This analysis provides a foundation for future research on infrastructure development, resource distribution, and economic well-being in Toronto. Future studies could explore additional factors that influence budget allocations and building permit issuance, such as infrastructure needs, community priorities, and political considerations. By incorporating these variables into the analysis, researchers can gain a more comprehensive understanding of how municipal budgets are allocated and how construction activity is distributed across the city's wards.

In terms of policy recommendations, the city should adopt equity-based budgeting to ensure underfunded, high-density wards receive adequate resources, particularly for essential services like health and safety. Toronto could also implement a baseline funding model for high-need areas and enhance public engagement in the budget process, ensuring that residents of under served wards have a voice in resource allocation. These actions would promote more transparent, balanced, and equitable urban governance.

8 Appendix

8.1 Data Tables

8.1.1 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

8.2 Model Details

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