Are Lower Income Communities Given More Noise Exemptions*

My subtitle if needed

Siddharth Gowda

September 24, 2024

TODO: FINISH THIS LATER (ABSTRACT)

1 Table of Contents

TODO: Work in Progress

2 Introduction

Noise pollution is a overlooked, but serious and common problem in modern cities. Noise pollution has been linked with heart issues, irregular sleep, hearing loss, and mental health issues (Iberdrola 2024 - fix citation later). Hence, Toronto city officials have identified noise pollution as a problem and created (**NoiseBylaws?**) to limit at what times certain noises like construction can occur. However, sometimes noise needs to be allowed during quiet hours. For instance, some building need to continue pouring cement overnight, otherwise the building will have safety risks. As a result, the Toronto government has also created a system of noise exemptions.

This paper explores whether or not these exemptions are getting abuse. Specifically, we want to know if lower-income communities are more likely to get noise exemptions. This is part of a much larger phenomenon, which is that poorer communities are suffer more from noise pollution compared to affluent ones. [Insert sentence showing the results from some external study] Moreover, all this does is further increase lifestyle differences between low-income and higher income-individuals. So, it is critical to make sure that Toronto's noise exemptions are not furthering this gap, especially since noise exemptions are often glance over in terms of their

---

*Open Data Toronto: https://open.toronto.ca/

addition to noise pollution compared to other contributors like late night traffic and airport plane landings. This paper attempts to fill that gap.

To do this, we used public available data on noise exemptions provided by the government of Toronto and we mapped the area of the exemption to the area's income. This was done by estimating the income by looking at the ward where the permit's company is working in. From that, we determined if there was a relationship between the two variables. Furthermore, we look at other factors such the type of permits given when determining the relationship. Overall, we determined that there was no evidence that lower-income communities were more likely to have more noise exemptions. On the contrary, we found moderate evidence for the opposite: higher income communities had more noise exemptions, not matter the type of exemptions that were given. This is important because it provides some evidence that noise exemptions are not disproportionately creating more noise pollution for lower income communities.

In terms of the paper's structure, it is organized into three main sections not including the introduction and table of Contents. The section # explores the data, its origins, potential issues, and relationships, while the section # provides a deeper discussion of the findings from the data. Finally, the section # addresses the paper's limitations and suggests potential next steps for future research.

3 Data

3.1 Overview

All data for this investigation was provided by (**OpenDataToronto?**). This data sets after Section 3.2 came to 1227 noise exemption permit details. Furthermore, this (**OpenDataToronto?**) library is created and maintained by government of Toronto. Specifically, this data was obtained from three different data sets provided in the library. The first data set was obtained from the Noise Exemption Permits package. This data set included everything related to noise exemption permits, including, the day the permit was given, the permit type, the conditions behind it's use, the ward the permit is operating in and more. More about this in Table 1. This data set was last updated 2024-09-23.

The rest of the data sets come from the Ward Profiles (25-Ward Model). This package contains all the information someone would need about Toronto ward's. It was last updated 2024-09-17. As for the data sets, the more important one comes from the 2021 Census. It contains demographic and socioeconomic data about all of the wards in Toronto. It's important to note here that some of the data in that dataset was created based on 25% samples of the census. Consequently, variable that were created based on 25% census samples will be denoted in Table 1 The final data set is simply a mapping of the each ward number to the ward's total area in squared kilometers.

All data analysis was performed using R Core Team (2023), (**tidyverse?**), (**janitor?**), and (**ggplot2?**). Also, (**kintir?**) was used in order to finalize and create the output of this report.

3.2 Data Cleaning

Some noise exemption data had missing values and those were rows. The main reason this occurred was because quite a few of noise exemption permit entries did not have ward numbers. Also all permit issue date and permit expected end date values were all converted to years for simplicity purposes as the paper is not concerned about exactly when these permits were issued and ended. It's is only concerned about when these permits were issued to determine whether the data is relevant to present day Toronto. Additionally, all three of data sets were merged into one data set so each permit has all the information is needs about the ward it is residing in. This was soley done to make creating graphs, tables, and other forms of analysis easier.

Table 1: Sample of Noise Exmption Dataset

Permit Type	Ward Number	Exemption Issue Year	Expected Permit End Year	Ward Total Area (km squared)	Ward Total Population	Ward Median Income (CAD)
construction	3	2024	2024	39.99417	139920	47600

Variable Name	Description
Permit Type	The type of the permit. More on this in Section 3.2.2
Ward Number	The number of the ward of the address the permit's company is working in
Exemption Issue Year	The year the permit was issued
Expected Permit End Year	The year the government expects this permit to end
Ward Total Area	The total area the ward takes in squared kilometers
Ward Population	The number of people that live in the ward
Ward Median Income	The median income of people in that ward (CAD)

3.2.1 Data Years

Issue Year	Number of Exemptions
2019	1
2023	2
2024	1224

Expected End Year	Number of Exemptions
2024	1206
2025	21

TODO

The table shows that almost all permits have been issued in 2024 and expected to end sometime in 2024 or 2025. It's is important to note that this was not deliberate choice and that this is merely a limitation of the data. However, this should not be viewed as a limitation because having all of the data being from 2019 and beyond makes sure that all this data is relevant to how noise exemption permits are issued now.

3.2.2 Types of Permits

Table 5: All Exemption Categories

Type	Number of Permits
amplified sound	874
amplified sound (level 1)	22
amplified sound (level 2)	3
amplified sound (level 3)	3
construction	151
continuous pour	26
continuous pour and/or large crane	131
large crane	13
other sound	3
other sound (level 2)	1

Noise permits are applied to for a variety of reasons. These are all the ones listed in the data set. In reality there are more and take a look (**NoiseToronto?**) if interested in finding out more. It's clear that amplified sounds which are often required for things like concerted are the most common form of noise permit exemption.

TODO: add name and captions

Permit Type	Description
Amplified Sound	Sound made by an electric device. Often required for musical festivals.
Construction	Self explanatory (TODO)
Continuous Pour	Continuously pouring some liquid, like concrete, that cannot be interrupted
Large Crane	Some sort of work that requires a crane (usually for a high rise building)
Other Sound	Self-explanatory

TODO (will add the rest of the types later).

However, for this analysis we will group the permit types into construction related, non-constructed related, and other. This is done not only to make things simpler, but because often times these construction related permit types are necessary and cannot be avoid and could potentially benefit a community while things like amplified sound are usually not necessary.

Non-construction type includes: Amplified

Construction type includes: Construction, Continuous Pour, Large Crane

Other includes: Other Sounds

Table 7: Relevant Exemption Categories

Type	Number of Permits
construction	321
non-construction	902
other	4

Even after merging the construction types together. Non-construction or amplified sound types are by far the most common type permit, almost taking up 75% of permits.

3.3 Exemption Distribution by Ward

Based on the Figure 1 we can see that most wards give out more non-construction permits that construction permits. Hence, it's important to see how income is related to number of
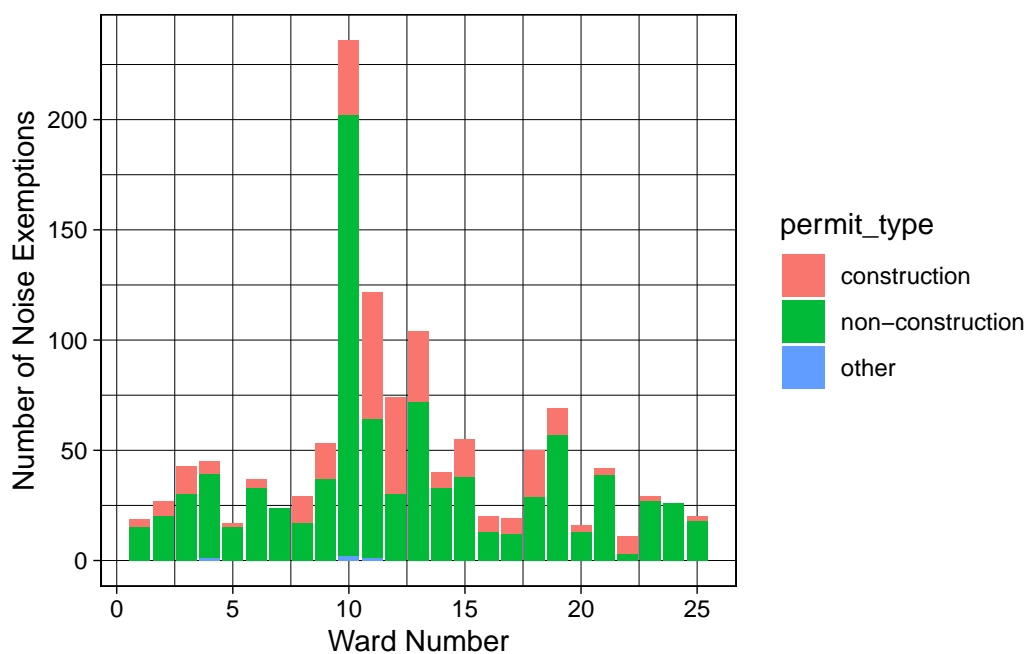
Figure 1: Noise Exemptions by Ward

Table 8: Outliers

Table 9

min	Q1	median	Q3	max	IQR
11	20	37	53	236	33

Table 10

ward	exemptions
10	236
11	122
13	104

exemptions based on each type, so general data results are not biased towards non-constructive exemptions.

Moreover, from Figure 1 and Table 8, it's clear that wards 13, 11, and especially ten are outlines in terms of number of exemptions given compared to the rest of the data. However, for the purpose of this paper, we will not consider these data points as outliers, so they will not be discarded from the analysis. This is these are still wards of Toronto and their wards cannot be excluded when determining any conclusion or relationships.

3.4 Income Noise Exemption Relationship
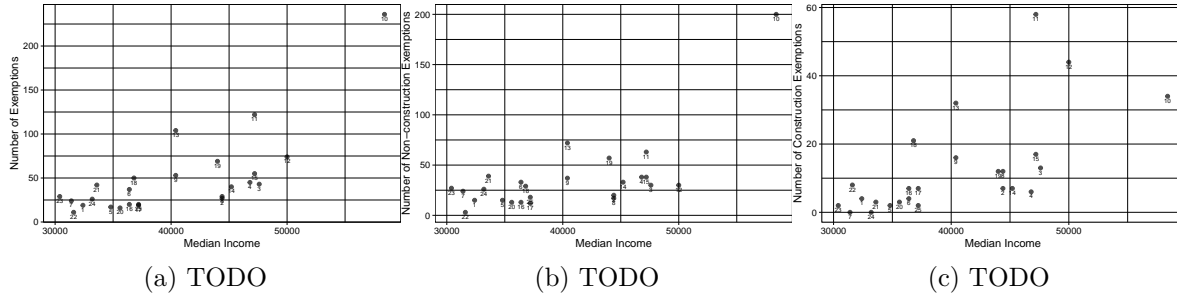

(a) TODO   (b) TODO   (c) TODO

Figure 2: Noise Exemptions by Ward

Based on the Figure 2. There is not seem to be a negative relation ship between median ward income and number of exemptions. However, by looking at the plot, there does seem to me a moderate positive relationship between median income and number of exemptions for all types of permit, although the construction permit plot's relationship does appear to be weaker.

It is important to note that if we hypothetically removed the outliers (ward 10, 11, 13), the relationship would appear to be a bit weaker, but there still appears to be a moderate positive relationship.

3.5 Testing for Hidden Confounding relationships

Figure 3 explores a ward's population is a good predictor of a ward's population and the number of permit exemptions given. Based on the plots there does seem to be a moderate positive relationship between a ward's population and a ward's medium income. Likewise, there is a moderate positive relationship between ward population and the number of noise exemptions a ward has given although this relationship is not as strong as population and median income.

However, we need to also consider that if we hypothetically remove the outlines from population graph. Then there appeared to be very little if not no relationship between population and median income.
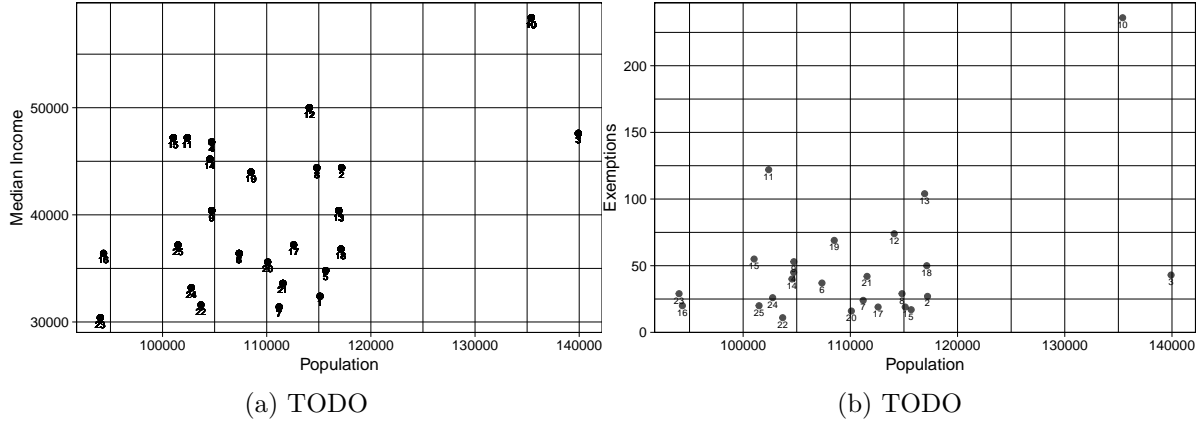
(a) TODO   (b) TODO

Figure 3: Ward Population impact on Medium Impact

4 Discussion

TODO: add correlation numbers, and other numbers

Based on Section 3.4, we have evidence that suggests that noise exemption permits are not disproportionately given out to lower-income communities. This was done by look at the relationship between medium income of wards and the total permits given in those wards. Furthermore, after cases for the types of permits given, we found no evidence for their being more construction related permits or non-constructions permits given to lower income wards.

This finding can be used in a variety of ways. For one, since we know that usually lower income communities are more likely to affected by noise pollution, we now understand that this noise pollution typically does not come from government noise exemption permits. Hence, city staff and officials should focus their efforts on combating other forms of noise pollution in low-income eras.

4.1 Unexpected Relationship

Surprisingly, we discovered that there is a moderate positive relationship between a ward's median income and the number of exemptions given. This was also true when casing for construction and non-construction based permits. For the construction permits, it is reasonable to assume that higher income-areas have more construction permits since more companies will want to invest their, build building, and those same companies and people will need to continue to maintain those building. So, the city could potentially benefit by investing more in these lower income areas. However, it is a bit unclear why there are more non-construction (amplified sound) exemptions. Nevertheless, city officials could use this finding to discuss whether or not these exemptions for amplified sound are being given out too frequently especially since they are oftentimes not necessary for growing the community like construction related ones are.

4.2 Potential Confounds

4.3 Weaknesses and Next Steps

The biggest weakness in this study was the use of wards as aggregators. The loss of specificity of the data when using wards made a few outliers (Wards 10, 11, and 13) have significant impact on the potential relationships that could be formed with income and noise exemptions. Unfortunate, wards 10, 11, and 13 cannot be ignored until most outliers. This is because there are only 25 wards in Toronto, so removing three data points is removing a lot of data. Moreover though, the data from these wards are not junk they are accurate reflection how noise and income are related in Toronto.

Additionally, using wards to determine socio-economic status can quickly lead to over generalized results. In particular, simply because a ward on average is richer than other wards, it does not mean that particular area where the noise permit has been used given is a rich area.

In terms of next steps, the first step would be to determine even more specifically the socioeconomic status of an area based on a specific address given in the application permit. Then based on this do similar analysis to determine if there is a true relationship between income and noise permits. Furthermore, in future studies regarding this topic, we would benefit from trying to model the relationship income and noise exemptions. Not only does create a more indepth quantification of the reltionship, it also provides a much more throughout way of factoring for confounding variables.

References

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