Exploring the influence of low-cost food programs on crime density
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ECON 326

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Introduction

It is well-documented that poverty and crime are closely correlated, with economic disadvantage often linked to higher rates of both property and violent crime (Hannon & DeFina, 2005). Poverty contributes to environments characterized by limited access to resources, social disorganization, and heightened stress, all of which can increase the likelihood of criminal activity. While these relationships are broadly established, in order to inform policy decisions, it can be valuable to understand what specific factors within low-income communities shape crime dynamics. In particular, free and low-cost food programs, in mitigating or exacerbating crime rates warrants closer examination.

Existing literature provides valuable context on the intersection of social services and crime. Studies suggest that a lack of socioeconomic support, such as food assistance programs, can increase economic desperation and worsen community stability, potentially increasing crime rates (Jackson et al., 2018). However, other research shows that concentrating social services in specific areas can inadvertently increase social tensions and stigma, undermining community cohesion. For example, housing assistance programs like the Moving to Opportunity initiative have sometimes failed to integrate recipients into supportive networks, limiting their ability to reduce crime (Kling et al., 2005). Despite these mixed findings, little is known about how the density of food programs specifically influences crime patterns within low-income communities, particularly in Vancouver.

This gap in the literature is especially pressing as food insecurity is on the rise in Vancouver. Recent data indicate that an increasing number of households in the city, especially in economically disadvantaged neighborhoods, are struggling to afford sufficient and nutritious food (Greater Vancouver Food Bank, 2023). In response, the have been more food-related social programs implemented in Vancouver. While these programs aim to address hunger and foster community well-being, their broader social implications, especially concerning crime density, have not been thoroughly studied.

This paper seeks to explore the relationship between the density of free and low-cost food programs and the density of property and violent crime in Vancouver's low-income neighborhoods by answering the question, **how does the density of free and low-cost food programs influence property and violent crime density in low-income communities in Vancouver?** The findings have important implications for policymakers and urban planners, offering evidence-based insights to optimize the design and implementation of food assistance programs to enhance their benefits while minimizing potential externalities.

Data

Canadian Census, 2021

We used the 2021 Canadian census data set to obtain the Population Density, Household Size, and Low-Income Density of neighborhoods in Vancouver. We aimed to establish a relationship between these factors and the crime rate within those specific communities. We considered the following variables:

Population, 2021: `v_CA21_1`
This provided us with a sample population to aid us in answering our research question. This numeric variable gave us quantitative values for the number of people within our sample along with population data specific to our chosen year. This enabled us to make clearer comparisons.

Population density per square kilometer: `v_CA21_6`
This allowed us to separate the population into specific locations to see the density within each neighborhood and provide context behind the crime rates in the area. It also helped us specifically pinpoint the locations of low-cost food programs. The unit for this variable represents the number of people.

Average household size: `v_CA21_452`
This variable consists of quantitative data about the household composition which influenced the crime rate. This provided a brief estimate of income brackets within the neighborhood to pinpoint which locations consist of low-income earners who might need low-income food plans. This indicated that neighborhoods with a higher average number of people per private household tend to have lower crime density.

Prevalence of low income based on the Low-income measure, after tax (LIM-AT)(%): `v_CA21_1040`
This variable provided an indication of household financial vulnerability that helped examine a relationship between low income, access to food, and the crime rate. The data is represented in the form of percentages in a given area and is a relative measure in relation to median income.

Prevalence of low income based on the Low-income based on the Low-income cut-offs, after tax (LICO-AT)(%): `v_CA21_1085`
This variable is a key indicator of financial strain that highlights the need for food programs as it takes into account living costs. It allowed us to target areas where food insecurity may be high and food programs would be most likely needed. This is an absolute measure where the units are given in the form of percentages.

Income statistics for private households: `v_CA21_905`
This variable helped identify low-income households to better understand the relationship between crime rates and low-income households. It provided information about income/earning levels.

Free and Low-Cost Food Programs, Vancouver

From the Free and Low-Cost Food Programs data set, we considered the following variables:

Neighborhood the facility is located: `local_areas`
This displayed the geographical distribution of food programs that can be geographically matched with crime rate locations to study the relationship between the two.

Latitude and Longitude of facility: `geom`
This provided a more specific location of each neighborhood we were studying, increasing the accuracy of our findings. This provides more detailed data to analyze the proximity to crime incidents. We analyzed the proximity of crime occurrence to food program locations. It is given in terms of coordinates.

Is the facility operational: `program_status`
This determined the availability of food resources to understand if the issue of food security is dealt with. This allowed us to isolate the effect. Within this variable data is either 'open' or 'closed' allowing us to disregard 'closed' food programs as they do not contribute to solving food insecurity. The data set contains the location of free/low-cost food programs, food banks, grocery hampers, low-cost groceries, or grocery vouchers in Vancouver. These are valuable specifications of the low-food programs to better understand the reason for their location.

Vancouver Police Department Crime Data, 2021

For the VPD Crime data set, we calculated the total number of crimes committed in 2021. We matched the location specifications with food program locations to better study their relationship through spatial analysis. We transformed the location data stored in the X and Y columns to match Census Dissemination Areas. To

do this, we converted from the projection format of the crime data to that of the census. We then calculated the density of crime within each dissemination area. By converting the location data to be projected the same way, we were able to make comparisons across all three of our data-sets.

Summary Statistics

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Table 1: Summary Statistics of Model Variables

	Mean	SD	Max	Median
food_density	1.199	15.420	386.598	0.000
low_income	0.459	0.498	1.000	0.000
pop_density.x	10258.448	10518.869	76474.359	6900.714
v_CA21_452	2.311	0.594	3.800	2.400

Model

To answer this research question, we will use a multiple linear regression model that explores the relationship between food program density and crime rates in low-income communities, with the equation:

$$\begin{aligned}(\text{Crime Density})_i = \beta_0 &+ \beta_1(\text{Food Program Density} \cdot \text{Low Income})_i \\ &+ \beta_2(\text{Food Program Density})_i + \beta_3(\text{Population Density})_i \\ &+ \beta_4(\text{Household Size})_i + \beta_5(\text{Low Income})_i + \epsilon_i.\end{aligned}$$

In this regression equation, the dependent variable Crime Density$_i$ represents the density of crimes per area for each census dissemination area. Our key parameter of interest is β_1 which is the interaction term that allows us to isolate the effect of food programs within low-income neighbourhoods only, by multiplying Food Program Density$_i$ which measures the density of free or low-cost food programs in the area by the dummy variable Low Income$_i$ which takes on the value 0 or 1 depending on whether we classify it as a low-income neighbourhood. The covariates are Food Program Density$_i$, Population Density$_i$, Household Size$_i$, and Low Income$_i$, which are variables that may influence crime in a neighbourhood on their own. Including these covariates allows us to isolate the effect of food program density on crime density in low income areas by controlling these variables. The parameter β_0 is the intercept, which represents the expected value of the crime density when the independent variables are equal to zero. The other parameters, β_i, where $i \neq 0$, represents the change in the crime density for a one-unit increase in each variable, holding the other variables constant. This model assumes that the factors influence crime density independently and that the relationships are linear.

Our first specification is such that:

$$\begin{aligned}(\text{Crime Density})_i = \beta_0 + \beta_2(\text{Food Program Density})_i + \beta_3(\text{Population Density})_i + \\ \beta_4(\text{Household Size})_i + \beta_5(\text{Low Income})_i + \epsilon_i.\end{aligned}$$

Our second specification is such that:

$$(\text{Crime Density})_i = \beta_0 + \beta_2(\text{Food Program Density})_i + \beta_5(\text{Low Income})_i + \epsilon_i.$$

Table of Results

Here we see the results for our model*NOTE THIS TEXT IS HERE SO THE TABLE RENDERS AFTER THE HEADER... soo maybe write something nice as fluff here:D

Table 2: Models for Crime Density

	Dependent variable:		
	Crime Density		
	(1)	(2)	(3)
Food Program Density	−0.203	8.053***	9.631***
	(2.154)	(0.771)	(0.897)
Population Density	0.043***	0.044***	
	(0.001)	(0.001)	
Household Size	−517.756***	−517.272***	
	(22.439)	(22.461)	
Low Income	244.697***	252.689***	577.872***
	(24.734)	(24.682)	(27.744)
Food Density:Low Income	9.460***		
	(2.305)		
Constant	1,291.286***	1,283.891***	383.969***
	(62.011)	(62.047)	(18.802)
Observations	7,860	7,860	7,860
R^2	0.315	0.313	0.067
Adjusted R^2	0.314	0.313	0.067
Residual Std. Error	1,050.245 (df = 7854)	1,051.304 (df = 7855)	1,225.029 (df = 7857)
F Statistic	720.960*** (df = 5; 7854)	895.186*** (df = 4; 7855)	282.621*** (df = 2; 7857)
Note:			*p<0.1; **p<0.05; ***p<0.01

Discussion

Summary of Results

The results provide insight into the relationship between the density of free and low-cost food programs and crime density in Vancouver, focusing on low-income neighborhoods.

Model with All Variables

Model (1) includes all variables, including the controls and the interaction term which tests whether the effect of food program density on crime density differs in low-income neighborhoods.

- **Food Program Density**:
  The coefficient is **-0.203**, suggesting that crime density slightly decreases for every one-unit increase in the density of food programs. However, the relationship is not statistically significant in this model. Therefore, we cannot conclusively assert that increased food program density decreases crime density.
- **Interaction Term (food_density:low_income)**:
  The coefficient for the interaction term is **9.460**, which implies a positive adjustment to the effect of food program density on crime density in low-income areas. This result is statistically significant. This suggests that the combined impact of increased food program density and being a low-income neighborhood significantly increases crime density.
- **Low-Income Neighborhoods (low_income)**:
  The coefficient is **244.697**, which is large and statistically significant. This shows that being a low-income neighborhood is strongly associated with increased crime density, regardless of food program density.

- **Population Density (population_density)**:
  A significant positive coefficient **(0.043)** indicates that as population density increases (more people per square kilometer), crime density also rises.
- **Household Size (household_size)**:
  The coefficient is **-517.756**, which is statistically significant. This indicates that neighborhoods with a higher average number of people per private household tend to have lower crime density.
- $R^2 =$ **0.315**:
  The R-squared value for this model is 0.315, suggesting that it does not fully explain the variation in crime density. This suggests that more variables must be studied to understand the relationship between food program density and crime density in low-income neighbourhoods.

Model Without the Interaction Term

In Model (2), the interaction term is removed, allowing us to focus on the independent effects of each variable. The only key difference in the results is the relationship between the food density and crime rate:

- **Food Program Density (food_density)**:
  The coefficient increases to **8.054** and becomes highly significant. This suggests a positive association between food program density and crime density. This result is statistically significant, whereas it was insignificant for Model (1), suggesting that the relationship is positive, not negative.
- **Low-Income Neighborhoods (low_income)**:
  The coefficient remains large and highly significant **(252.689)**, indicating that being a low-income neighborhood causes higher crime density.
- **Population Density (population_density) and Household Size (household_size)**:
  Both variables remain significant and retain their direction. Higher population density is associated with higher crime density, while a larger household size is correlated with lower crime density.
- $R^2 =$ **0.313**:
  The R-squared value for model 3 is similar to 2, suggesting that it explains a similar proportion of the variation in crime density. This implies more variables are needed to explore the relationship between food program density and crime density.

Model Focused on Food Density, Crime, and Low Income

Model (3) isolates food program density (food_density) and low-income neighborhoods (low_income) to examine their direct effects on crime density, also excluding the interaction term.

- **Food Program Density (food_density)**:
  The coefficient is **9.631**, and it is highly significant. This suggests a strong positive relationship between food program density and crime density.
- **Low-Income Neighborhoods (low_income)**:
  The coefficient for low-income neighborhoods is **577.872**, and it remains highly significant. This confirms that low-income status is significantly correlated with higher crime density, independent of food program density.
- $R^2 =$ **0.067**:
  This reduced model explains only 6.7% of the variance in crime density, much less than the previous models, highlighting the importance of the omitted variables.

This simplified model highlights the primary relationships but does not account for control variables like population density or household size which may also affect the crime density in different neighbourhoods, causing it to have a very low R-squared of 0.067 which implies that the model is almost non-explanatory. This suggests it explains nearly nothing about the variation in crime density.

Key Insights from All Models

Low income causes higher crime density: Across all the models, low-income status shows a strong and significant positive relationship with crime density. This emphasizes the role of financial hardship in influencing crime rates.

Food Program Density has a positive relationship with Crime Density: The positive relationship is significant in models (2) and (3), suggesting that increased food program density increases crime density. This correlation likely reflects the placement of food programs in high-crime areas rather than a causal impact on crime.

Demographic Variables: - Population density is positively associated with crime density, reflecting the greater likelihood of criminal activity in busy areas. - Household Size is negatively associated with crime density, suggesting that larger household sizes may provide greater social support in the form of familial or household relationships that cause a lower likelihood of criminal behavior.

Interaction Effects are Significant: The interaction between food program density and low-income status significantly influences crime density, indicating that being a low income neighborhood causes food program density to have an even stronger positive correlation with crime density.

Drawbacks and Limitations

Endogeneity:
The placement of food programs is likely endogenous to crime rates, as programs are often located in areas with higher need. This reverse causality could bias the results, making it difficult to interpret the direction of the relationship.

Omitted Variable Bias:
Important variables, such as law enforcement presence, housing quality, and social capital, are not included in the analysis. This is perhaps why the R-squared values are low in all 3 models.

Areas of crime:
Although crimes occur in a particular area, it does not mean they are committed by people residing in that area. Therefore, the control variables including population density, low income, and household size may not be measuring the living situations of the actual crime perpetrators.

The results show that food program density is positively associated with crime density, particularly in low-income neighborhoods. We will ensure our results are robust by using model (1) on subgroups of Vancouver neighborhoods, ensuring we reach the same conclusions. However, due to potentialendogeneity, this positive relationship is likely not causal as food programs may be strategically placed in areas that have high crime density. To ensure that the estimates of the regression coefficients are unbiased we will perform White's test as a specification check for heteroskedasticity.

Heteroskedasticity

To check our model for heteroskedasticity, we conducted the Breusch-Pagan Test and the White's Test. For the Breusch-Pagan test, the p-value we obtained was 2.930512e-93 which is very close to 0, and smaller than any conventional significance level, we reject the null hypothesis of homoskedasticity. We got a similar result for the White's Test. The p-value we obtained was 2.15e-128, which similarly suggests heteroskedasticity. Therefore, there is strong evidence of heteroskedasticity in our model which implied that the variance of error varies across the independent variables. This violates the assumption of homoskedasticity for Ordinary Least Squares (OLS) regression. Therefore, the standard error of our estimates is biased which may lead to misleading conclusions. Given more time and resources, we would use a different estimator due to the presence of heteroskedasticity which makes OLS no longer the Best Linear Unbiased Estimator.

Robustness

To check the robustness of our results, we used the regression equation from Model (1) on subgroups of areas. The results for these subgroups can be seen in Table 3, which can be found in the Appendix. We clustered based on the census dissemination areas, using k-means to form four subgroups. Our results show that the relationship between population density and crime density, and average household size and crime density, amongst the clusters are consistent with our results. However, the relationships between other variables change across the clusters, being inconsistent with our results. Therefore, we cannot conclude that our conclusions are robust.

Conclusion

The analysis provides evidence that food program density is positively associated with crime density, particularly in low-income neighborhoods. However, due to potential endogeneity and omitted variable bias, the results should not be interpreted causally. The strong association between low-income status and crime highlights the importance of addressing socioeconomic inequality as a key strategy for reducing crime. Extensions such as IV approaches, spatial econometrics, and additional controls will strengthen the robustness and policy relevance of the findings.

Works Cited

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Appendix

Table 3: Models based on k-means clustering subgroups

	Dependent variable:			
	Crime Density			
	(1)	(2)	(3)	(4)
Food Program Density	0.665**	−7.841	0.994***	5.133***
	(0.269)	(5.525)	(0.295)	(0.428)
Population Density	0.027***	0.026***	0.016***	0.012***
	(0.001)	(0.001)	(0.0002)	(0.0003)
Household Size	−256.874***	−1,396.640***	−51.092***	−13.752***
	(6.370)	(50.163)	(2.627)	(1.908)
Low Income	−12.819**	927.569***	5.528**	36.705***
	(6.522)	(31.691)	(2.231)	(2.923)
Food Density:Low Income	−0.265	16.712***	−2.823***	−0.523
	(0.363)	(5.552)	(0.427)	(0.608)
Constant	819.960***	3,079.475***	236.881***	66.636***
	(17.592)	(95.768)	(7.746)	(4.931)
Observations	15,898	16,451	18,354	11,347
R^2	0.252	0.193	0.385	0.200
Adjusted R^2	0.251	0.193	0.385	0.200
Residual Std. Error	321.788 (df = 15892)	1,846.752 (df = 16445)	133.450 (df = 18348)	127.657 (df = 11341)
F Statistic	1,068.458*** (df = 5; 15892)	787.362*** (df = 5; 16445)	2,297.625*** (df = 5; 18348)	568.009*** (df = 5; 11341)
Note:				*p<0.1; **p<0.05; ***p<0.01