Riots and Subways: a Relationship Moderated by the Neighborhood's Income Level

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Abstract

Social disturbances due to socioeconomic and political factors were present in the media during 2019, including places like France, Hong Kong, Chile, Nigeria, Sudan, Haiti, and Lebanon. In October 2019, Chile saw massive demonstrations in the capital city of Santiago. As a result, the cost of damage to infrastructure during the first month of unrest is estimated at US$ 4.6 billion, and the cost to the Chilean economy was about US$ 3 billion, 1.1% of its Gross Domestic Product. This study aims to analyze how the topology of the public transport network affected the locations of the 2019 riots in Santiago. On average, we find a clear association between proximity to the subway network and riot density. This association is significant only in neighborhoods with residents in the highest and lowest income quartiles. When analyzing social unrest and the critical role of public transport, policymakers should consider the crucial role of income in the previous relationship.

1. Introduction

In October 2019, Chile saw massive demonstrations in the capital city of Santiago, triggered by a 3.8% rise in Metro fares. Within a few days, protesters turned violent, and the social turmoil rapidly spread to other cities, forcing the Government to declare a state of emergency and imposing military controls. As stated by Hribernik and Haynes (2020), the cost of damage to infrastructure during the first month of unrest is estimated at US$ 4.6 billion, and the cost to the Chilean economy was about US$ 3 billion, 1.1% of its Gross Domestic Product.

This article analyzes how the topology of Santiago's subway network affected the locations of the 2019 riots: we found a significant positive association between proximity to the subway network and riot density. The association is substantial only in Santiago's highest and lowest income neighborhoods (quartiles one and four).

To our knowledge, we provide the first quantitative study on the interplay between riot density, the urban transport network, and the neighborhood's income level. Previous evidence from the London riots in 2011 (Baudains et al., 2013) shows that transport network hubs enable riot formation. Also, Lim et al. (2007) and Rutherford et al. (2014) show that segregation is associated with social tension and violence.

As with any collective issue, the public disorder had a multifactorial origin. In the case of the London riots of 2011, Davis et al. (2013) found that deprivation and poor economic conditions were the main factors that influenced which areas of the city were more prone to violence in any one case of disorder. In the case of the Paris riots of 2005, the primary sociodemographic variable that may have led to the revolts was the proportion of young males aged between 16 and 24 with incomplete high school education (Bonnasse-Gahot et al., 2018). Meanwhile, Pires and Crooks (2017), using an agent-based model, social network analysis, and geographical information, pointed out that employment opportunities decrease social tension. However, they conclude that if only education is increased, the result is a more tense and unstable social context due to the rise of frustration and civil unrest.

Our findings also relate with the literature in the intersection between the geography of opportunity and the spatial mismatch hypothesis. For example, Stoll et al. (2000) and Liu (2009) find that minorities live farther from employment options than the general population. More specifically, Liu (2009) studies differences in the geography of opportunity for immigrants relative to other minorities in the USA.

2. Results

We took the public data available from SOSAFE (sosafeapp.com), an open platform on which users can report various incidents. These incidents may be blockades that disrupt road traffic, destruction of street signs, looting of supermarkets and stores, or arson of public and private premises. Data were taken for the first four days of demonstrations (October 18th–22nd, 2019). As the data included georeferenced and timestamped incidents, we performed a space-time analysis. The area this analysis covered was the same as that covered by Santiago's public transport system.

2.1 Descriptive Statistics

2.1.1. Temporal Evolution of the Activities

Fig. 1 shows the temporal evolution of public disorder incidents, where each bar represents one hour of activity. Dynamics first described by Burbeck, Raine, and Stark (1978) were replicated in the French riots of 2005 (Bonnasse-Gahot et al., 2018) and the London riots of 2011 (Davies et al., 2013). In recent work, the aggregated activity by Caroca Soto et al. (2020), the aggregated data collected by the Undersecretary of Human Rights for the Chilean Riots of 2019, also confirmed Burbeck's model. In this distribution, the activity is lowest around 8 a.m. and peaks at 10 p.m.

2.1.2. Riot Spatial Distribution Relative to the Subway Network

Fig. 2 shows the frequency of incidents against the distance to the closest subway station. There is an exponential decay in the activity as we move further away from the stations: 48.7% of all incidents occur one km or less from a station, and 82.8% occur three km or less. This clustering of activity around the subway network was the same on each day of disorder.

Using Eq. 6's measure of accessibility (see Appendix), we find that the subway network covers only 12.4% of the total area served by Santiago's public transport system. Fig. 3's panel A shows a heat map of riots alongside the subway network. There is a visible association between the location of subway stations and riot density. The previous visual association is substantial in high-income neighborhoods (see the city's northeast in Fig. 3's panel B).

2.2 Regression analysis

2.2.1. The Association Between Proximity to the Subway Network and Riot Density

There is a strong positive association between proximity to the subway network and riot density. Table 1 shows regression coefficients and standard errors of a one-kilometer increment change in proximity to the subway network; the latter variable is the negative of “distance to the subway network” in kilometers. In this analysis, the dependent variable is the log of riots per grid cell, where cells have a width and height of 200 m. Column (1) shows that every kilometer closer to the subway is associated with a 4.4% increase in riots (a coefficient of 4.391). Column (2) shows that this association is robust to the inclusion of income and educational covariates.

Table 1. The Association Between Proximity to the Subway Network and Riots Across Income Levels.

Dependent variable: log (riots)	(1) Bivariate regression	(2) As (1) plus covariates	(3) As (2) interacting proximity with income
Proximity to the subway network (km)	4.391***	3.734***	11.39***
	(1.218)	(1.355)	(3.072)
First income quartile		0.246	-3.774
		(5.317)	(8.549)
Second income quartile		3.455	-11.72
		(4.968)	(7.954)
Third income quartile		10.24**	-1.752
		(4.913)	(7.848)
Fourth income quartile (reference category)		0	0
		(0)	(0)
Proximity to the subway network ×			
First income quartile			-4.804
			(3.948)
Second income quartile			-11.68***
			(3.837)
Third income quartile			-10.31**
			(4.045)
Fourth income quartile (reference category)			0
			(0)
Free schools' value-added	No	Yes	Yes
Paid schools' value-added	No	Yes	Yes
Observations	2,096	1,879	1,879
R-squared	0.006	0.015	0.020

Notes: Columns (2) and (3) control for nearby publicly-funded and privately-funded school value-added in each cell, where gaussian weights decrease with distance to schools. We divided the Greater Santiago Area into a grid of 200 × 200 m. We calculated schools' value-added as the coefficient on a dummy on each school type. In these regressions to determine each school's value-added, the dependent variable is standardized test scores, and the covariates are parental education and income. Robust standard errors are in parentheses. All regressions include an intercept (not shown). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

2.2.2. A Heterogeneous Association Across Income Levels

Both Santiago's wealthiest and most impoverished areas drive the association between proximity to the subway network and riot density. Table 1's column (3) shows suggestive evidence that the association between proximity and riot density is non-significant in middle-class neighborhoods. In addition, coefficients on the second and third income quartiles and their interaction with proximity show non-significant coefficients. Table 1's column (4) shows that the association between proximity to the subway network and riot density is stronger in neighborhoods with predominantly wealthiest or poorest residents (first and fourth income quartiles).

3. Discussion

We presented a simple way to quantify the association between riot density and access to the subway network allowing for heterogeneity across neighborhoods' income levels. Spatial and temporal distributions using data about Chile's 2019 riots indicated that the peak of the riots' activity occurred around 10 p.m., and half of the riots took place at one kilometer or less from subway stations, showing an exponential decay with distance.

The association between riot density and proximity to the subway network is significant, both statistically and in policy terms. For example, on average, a neighborhood that is five kilometers closer to the subway network has a riot density 22% higher than the neighborhood farther away. This is of particular importance for the city of Santiago, as mobility studies indicate that most inhabitants tend to either stay in their community or travel to the city center (Dannemann et al., 2018). Therefore, it is not strange that the city center has the highest concentration of rioting activity. Unfortunately, we do not have the data to test whether most rioters traveled long distances to participate in city center demonstrations. However, anecdotal evidence shows that at least a fraction of the rioters traveled from the suburbs to riot (Olivares et al., 2020).

The association between proximity to the subway network and riot density is significant only in highest income and lowest income neighborhoods (first and fourth income quartiles). We hypothesize that the reason for the previously mentioned association in areas in the lowest income quartile is that inequality (one of the riots' motivations, according to Somma et al., 2020) burdens low-income families (Chetty et al., 2016). We also hypothesize that the association between proximity to the subway network and riot density in high-income districts could be due to these districts being more symbolic places to riot. When analyzing social unrest and the critical role of public transport, policymakers should consider the crucial role of income in the previous relationship.

Declarations

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Author Contributions

K.A contributed to the interpretation of results and data analysis. R.F. provided the expertise about public transport network on Santiago. C.C. prepared the data and performed the numerical analysis. All authors discussed the results and contributed to the final manuscript.

References

1. Baudains, P., Braithwaite, A., & Johnson, S. D. (2013). Target Choice During Extreme Events: A Discrete Spatial Choice Model of the 2011 London Riots. *Criminology*, *51*(2), 251–285. https://doi.org/10.1111/1745-9125.12004
2. Biba, S., Curtin, K. M., & Manca, G. (2014). Who Can Access Transit? Reviewing Methods for Determining Population Access to Bus Transit. *Cityscape*, *16*(2), 193–204.
3. Bonnasse-Gahot, L., Berestycki, H., Depuiset, M.-A., Gordon, M. B., Roché, S., Rodriguez, N., & Nadal, J.-P. (2018). Epidemiological modelling of the 2005 French riots: A spreading wave and the role of contagion. *Scientific Reports*, *8*(1), 107. https://doi.org/10.1038/s41598-017-18093-4
4. Burbeck, S. L., Raine, W. J., & Stark, M. J. A. (1978). The dynamics of riot growth: An epidemiological approach. *The Journal of Mathematical Sociology*, *6*(1), 1–22. https://doi.org/10.1080/0022250X.1978.9989878
5. Caroca Soto, P., Cartes, C., Davies, T. P., Olivari, J., Rica, S., & Vogt-Geisse, K. (2020). The anatomy of the 2019 Chilean social unrest. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, *30*(7), 073129. https://doi.org/10.1063/5.0006307
6. Chetty, R., Hendren, N., & Katz, L. F. (2016). The Effects of Exposure to Better Neighborhoods on Children: New Evidence from the Moving to Opportunity Experiment. *American Economic Review*, *106*(4), 855–902. https://doi.org/10.1257/aer.20150572
7. Dannemann, T., Sotomayor-Gómez, B., & Samaniego, H. (2018). The time geography of segregation during working hours. *Royal Society Open Science*, *5*(10), 180749. https://doi.org/10.1098/rsos.180749
8. Davies, T. P., Fry, H. M., Wilson, A. G., & Bishop, S. R. (2013). A mathematical model of the London riots and their policing. *Scientific Reports*, *3*(1), 1303. https://doi.org/10.1038/srep01303
9. Handy, S. L., & Niemeier, D. A. (1997). Measuring Accessibility: An Exploration of Issues and Alternatives. *Environment and Planning A: Economy and Space*, *29*(7), 1175–1194.

https://doi.org/10.1068/a291175

10. Hribernik, M., & Haynes, S. (2020). *47 countries witness surge in civil unrest – trend to continue in 2020—Political Risk Outlook 2020* (Political Risk Outlook 2020, p. 32). Verisk Maplecroft. https://www.maplecroft.com/insights/analysis/47-countries-witness-surge-in-civil-unrest/
11. Liu, C. Y. (2009). Ethnic enclave residence, employment, and commuting of Latino workers. *Journal of Policy Analysis and Management*, *28*(4), 600–625. https://doi.org/10.1002/pam.20457
12. Olivares, E., Piérola, G., & Román, C. (2020, October 3). El “incidente” en el Mapocho. *Pauta*. https://www.pauta.cl/politica/adolescente-empujado-carabineros-protestas-plaza-italia-en-rio-mapocho
13. O’Neill, W. A., Ramsey, R. D., & Chou, J. (1992). Analysis of Transit Service Areas Using Geographic Information Systems. *Transportation Research Record*, *1364*. https://trid.trb.org/view/371490
14. Somma, N. M., Bargsted, M., Pavlic, R. D., & Medel, R. M. (2020). No water in the oasis: The Chilean Spring of 2019–2020. *Social Movement Studies*, *0*(0), 1–8. https://doi.org/10.1080/14742837.2020.1727737
15. Stoll, M. A., Holzer, H. J., & Ihlanfeldt, K. R. (2000). Within cities and suburbs: Racial residential concentration and the spatial distribution of employment opportunities across sub-metropolitan areas. *Journal of Policy Analysis and Management*, *19*(2), 207–231. https://doi.org/10.1002/(SICI)1520-6688(200021)19:2<207::AID-PAM3>3.0.CO;2-H
16. Spiekermann, K., and Wegener, M. (1996). Trans-European networks and unequal accessibility in Europe. *European Journal of Regional Development*, 4(96), 35-42.

Figures

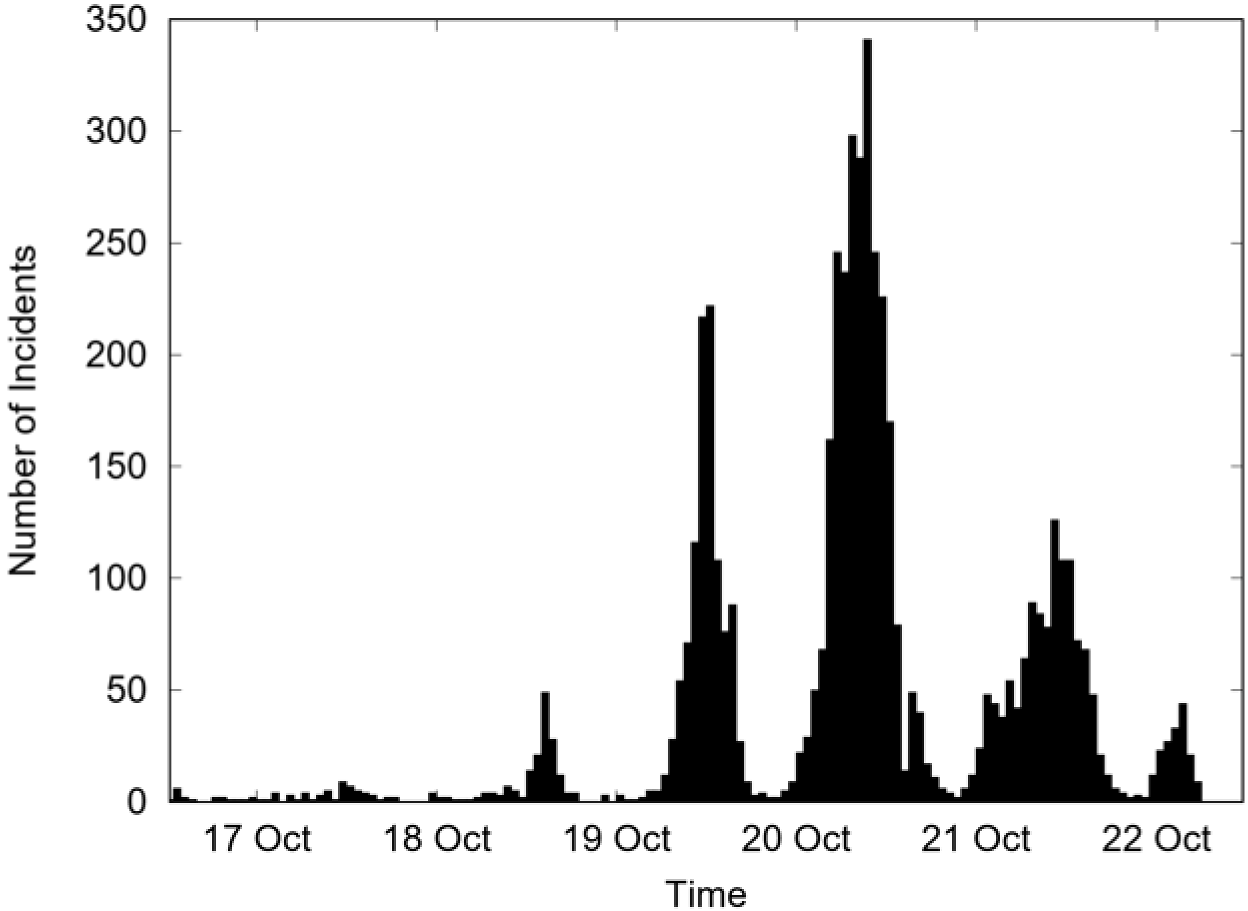

Figure 1

The number of incidents per hour for the riots’ first four days.

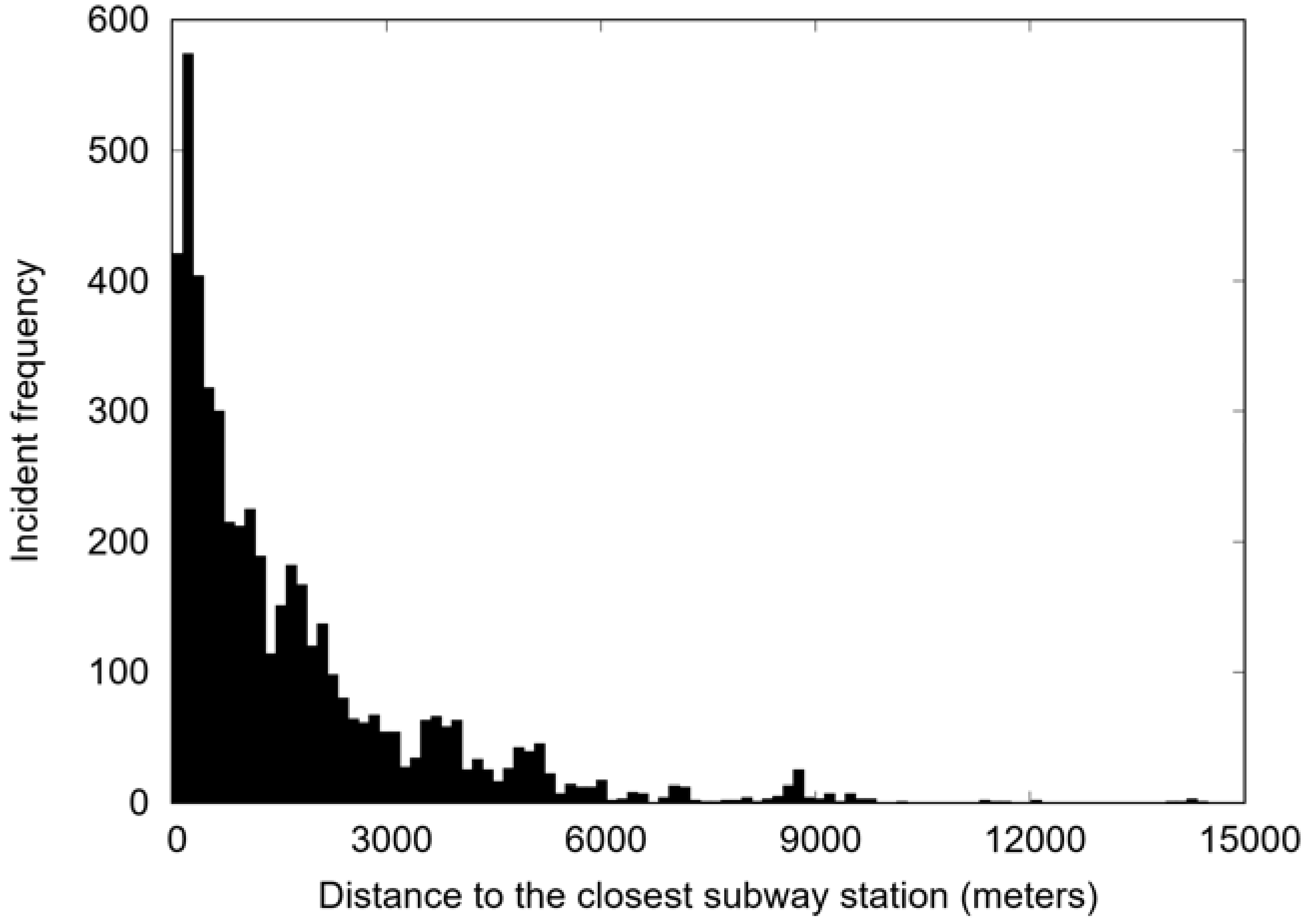

Figure 2

Frequency distribution of distances between incidents and subway stations.

Panel A. Incident density alongside subway network. *Panel B. Income distribution in Santiago shown alongside riot levels*

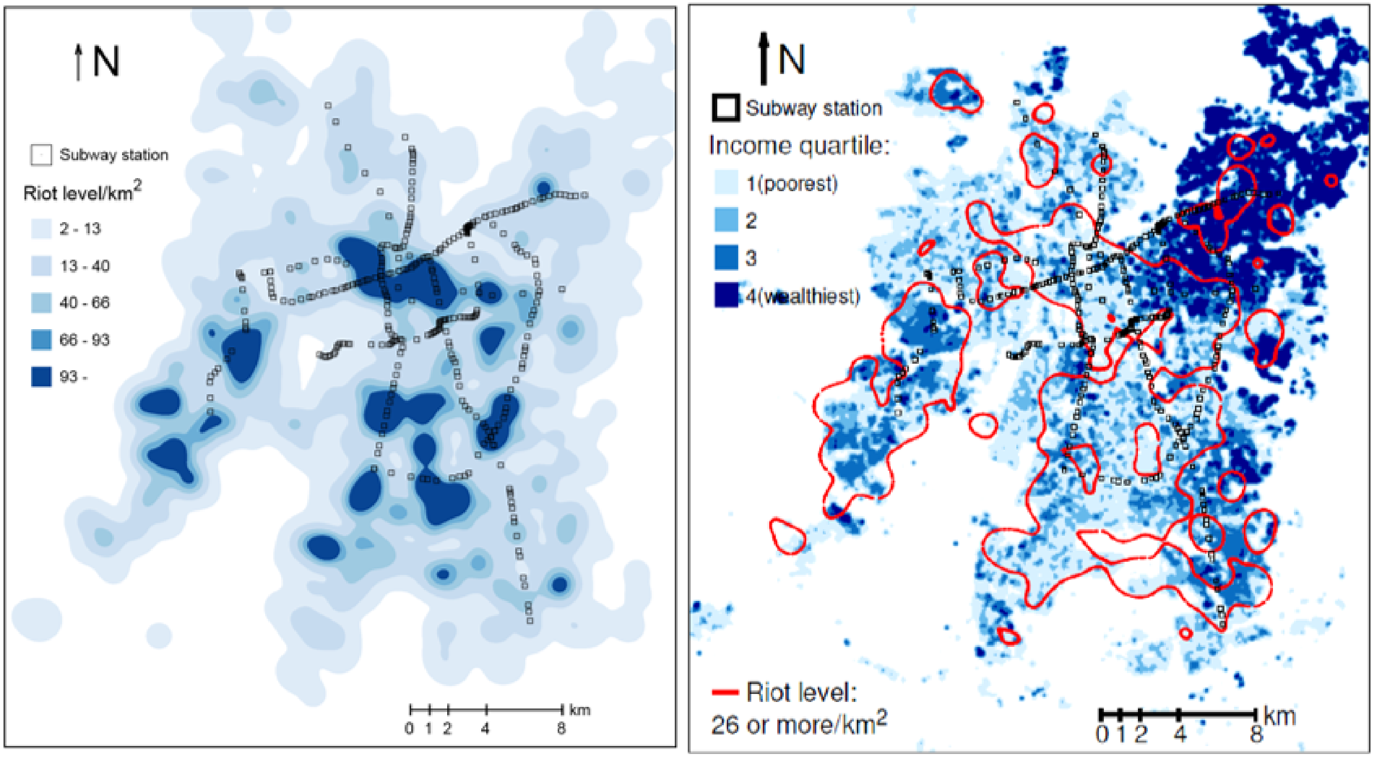

Figure 3

Incident density, the subway network, and income distribution.

Supplementary Files

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- Appendix.docx