Port-au-Prince Calling: Social Network Response to Social Unrest using Mobile Phone Metadata in Haiti

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Motivation

"When you are in trouble, you find out who your friends are." -Haitian proverb [1].

Calling behavior during crisis is revealing in that it expresses who and what people value. Do those who face unrest in their neighborhoods turn outward for support and information, or do they restrict their communications to their close friends, family and associates? In Haiti, social networks play an important role in accessing resources and information in the wake of crisis [2, 3]. Such *covariate shocks*—shocks correlated across households within a geographic area—can come in many forms. While natural disasters like earthquakes or hurricanes can precipitate intense times of "trouble" across a wide swath of a population, localized disruption due to protests, looting and civil unrest can be equally troubling albeit in a more isolated manner. We study how communication networks respond to acute civil unrest by considering how these localized shocks shift incentives to communicate through these networks.

Theoretical Model Set-Up

Our model draws on previous models of mobile phone calling and is modified to to account for tie strength [4, 2]. The caller chooses call duration to maximize utility, and has the following utility function and marginal cost of calling:

$$v_{ij}(d_{ijt}, z_{it}) = \alpha_{ij} d_{ijt} - \frac{1}{\epsilon_{ijt}(z_{it})} \frac{d_{ijt}^{\gamma}}{\gamma} \tag{1}$$

$$c_{it} = p + \phi(z_{it}) \tag{2}$$

where i is the caller (ego), j is the called (alter), and t is day, d is the duration of voice calls, α embodies the strength of tie, γ controls how quickly the marginal utility of calls diminishes, and p is price (per second). z is social unrest, which enters through two channels: (1) $\epsilon(.)$ is the information shock, where a higher shock indicates more relevant information, and (2) $\phi(.)$ is the attention cost of calling. That is, social unrest makes calling more informative, but also makes it more difficult to monitor one's surroundings.

Predictions

Solving the theoretical model, we are left with three predictions:

1. Fewer people will be contacted during social unrest
2. Strong ties are more likely to be contacted
3. Informed ties are more likely to be contacted

We also expect that an increase in information overall would increase total duration of calls, though this is not a formal prediction of the model. Ultimately, who is called depends on tie strength and information shock. In our empirical results we proxy for information shock with degree centrality. Table 1 depicts this trade off between between the 'strength of weak ties' and the 'weakness of long ties' [5, 6].

Table 1. Predictions of Duration Response by Tie Strength and Centrality

	Tie Strength	
Centrality	*Weak*	*Strong*
Low	**(−)** Socially distant, unlikely to have information	**(+/−?)** Socially close, but unlikely to have novel information: checking-in on close friends
High	**(+/−?)** Socially distant, likely to have information: searching for novel information	**(+)** Socially close, likely to have information: searching for trusted information

Data and Context

Social Unrest: Starting in 2018, Haiti faced a period of social unrest in response to reports of government corruption. In Port-au-Prince, This period included chaotic and decentralized mass demonstrations with crowd sizes of up to several thousand participants. Using embassy reports, we construct a georeferenced social unrest timeline including the date, time and coordinates of social unrest. This timeline captures five event types: protests, tire burning, roadblocks, shootings, and rock throwing, which are depicted in Figure 1.

Call Detail Records: We combine the social unrest data with a dataset of all phone calls from a mobile provider over the same period. This data features sender and receiver ID, duration, date, time, and tower/coordinates of calls. We construct a three-week baseline network to determine strong ties (>80th percentile of duration), central ties (>67th percentile of degree centrality), and users' home tower. We construct daily country-wide networks and build a five week panel of node outcomes (see Figure 2):

- *Contacts* captures the number people talked to in a given day (i.e., degree).
- *Duration* duration captures the total talk time in a day (in seconds).

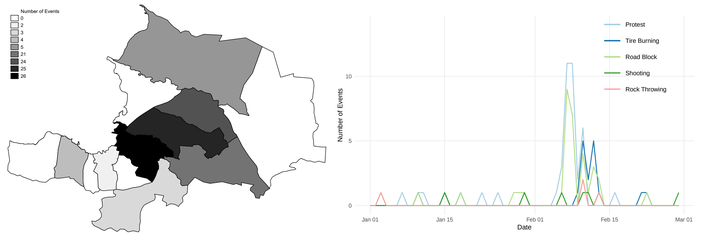

Figure 1. Geography (left) and timeline (right) of social unrest in the Port-au-Prince area, January-February 2019.

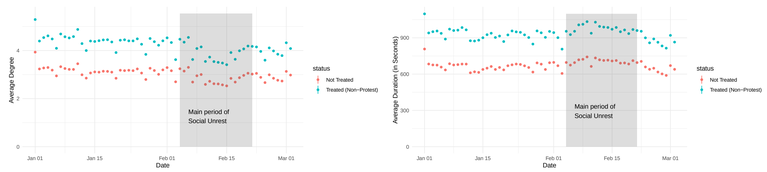

Figure 2. Daily contacts (left) and duration (in seconds, right) for those who are treated with non-protest social unrest vs. those who are never treated.

Empirical Strategy

We argue that these spatially isolated shocks serve as a natural experiment suitable for a modified difference-in-differences empirical strategy. To limit issues with anticipation effects, we restrict our analysis to the least predictable events, excluding protests from our definition of treatment. We estimate our treatment effects using the DID^M estimator, which is robust to variation in treatment timing with heterogeneous treatment effects, and flexible enough to allow units to leave treatment [7]. This estimator yields treatment effects from areas of Port-au-Prince that fall into and out of spells of social unrest. We restrict the sample to towers in Port-au-Prince. Users face an episode of social unrest if and when their most used tower is <1km from social unrest.

Results

We find that non-protest social unrest (i.e., instances of tire burning, shooting, roadblocks, and rock throwing) reduces contacts by 0.05 per day among those in a half kilometer of the event ($p < 0.001$). However, total duration stays roughly constant. To explore what and who people value in a time of crisis, we decompose these effects by tie strength and baseline degree. When we restrict to strong ties with low centrality, there is no reduction in the number of contacts—in contrast to the main effect and in other subgroups. While no groups have a significant positive increase in total duration in response to social unrest, it is notable that duration per contact increases by around 11 seconds among strong, high centrality contacts.

Table 2. DID^M estimates of effect of episode of non-protest social unrest on network usage

	Outcome			
	Contacts		Total Duration (s)	
Sample Restrictions	Effect	Std Err.†	Effect	Std Err.†
(None: Main Effect)	-0.048	(0.012)	-4.45	(6.99)
Strong, high centrality	-0.022	(0.006)	2.07	(3.53)
Strong, low centrality	0.002	(0.003)	-1.11	(3.13)
Weak, high centrality	-0.012	(0.005)	-1.51	(1.39)
Weak, low centrality	-0.016	(0.009)	-3.90	(3.55)

Sample: panel of 100,000 users from 1/21-2/24. † Block bootstrap with 500 repetitions.

Discussion and Policy Relevance

Our results suggest people talk with a smaller set of important contacts—consistent with the hypotheses of the theoretical model described above as well as evidence from from disparate shocks [8, 9]. We interpret these results as people checking in on their close friends, family, or associates as the uncertainty of unrest arises. However, we see evidence consistent with (limited) information search: despite talking to fewer strong ties with high centrality, those facing unrest spend more time on average talking to these contacts. This highlights the importance of gathering information through trusted ties [5, 6]. Policymakers seeking to diffuse timely information through word-of-mouth should cultivate a larger number of less central seeds as opposed to a smaller number of central but (likely) less trusted influencers.

References

[1] Vilmond Joegodson Déralciné and Paul Jackson. *Rocks in the Water, Rocks in the Sun: A Memior from the Heart of Haiti*. 2015.

[2] Guitele J. Rahill, N. Emel Ganapati, J. Calixte Clérismé, and Anuradha Mukherji. Shelter recovery in urban Haiti after the earthquake: The dual role of social capital. *Disasters*, 38(s1):S73–S93, April 2014.

[3] Erich J. Sommerfeldt. Disasters and Information Source Repertoires: Information Seeking and Information Sufficiency in Postearthquake Haiti. *Journal of Applied Communication Research*, 43(1):1–22, January 2015.

[4] Daniel Björkegren. The adoption of network goods: Evidence from the spread of mobile phones in Rwanda. *Review of Economic Studies*, 86(3):1033–1060, 2019.

[5] Mark Granovetter. The Strength of Weak Ties. *American Journal of Sociology*, 78(6), 1973.

[6] Damon Centola and Michael Macy. Complex Contagions and the Weakness of Long Ties. *American Journal of Sociology*, 113(3):702–734, November 2007.

[7] Clément de Chaisemartin and Xavier D'Haultfœuille. Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects. *American Economic Review*, 110(9):2964–2996, 2020.

[8] Daniel M Romero, Brian Uzzi, and Jon Kleinberg. Social Networks Under Stress. In *WWW '16: Proceedings of the 25th International Conference on World Wide Web*, 2016.

[9] Jayson S. Jia, Yiwei Li, Xin Lu, Yijian Ning, Nicholas A. Christakis, and Jianmin Jia. Triadic embeddedness structure in family networks predicts mobile communication response to a sudden natural disaster. *Nature Communications*, 12(1), 2021.