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ORIGINAL ARTICLE

Tents, Tweets, and Events: The Interplay Between Ongoing Protests and Social Media

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Recent protests have fuelled deliberations about the extent to which social media ignites popular uprisings. In this article, we use time-series data of Twitter, Facebook, and onsite protests to assess the Granger causality between social media streams and onsite developments at the Indignados, Occupy, and Brazilian Vinegar protests. After applying Gaussianization to the data, we found contentious communication on Twitter and Facebook forecasted onsite protest during the Indignados and Occupy protests, with bidirectional Granger causality between online and onsite protest in the Occupy series. Conversely, the Vinegar demonstrations presented Granger causality between Facebook and Twitter communication, and separately between protestors and injuries/arrests onsite. We conclude that the effective forecasting of protest activity likely varies across different instances of political unrest.

Keywords: Social Media, Contentious Politics, Granger Causality Test, Occupy, Indignados, Vinegar Protests.

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In this article, we scrutinize the oft-debated role of network communication in the 2011 Spanish May 15 Indignados, the 2011 Occupy movement, and the 2013 Vinegar protests in Brazil. Following results from recent investigations (Bakker & de Vreese, 2011; Borge-Holthoefer et al., 2011; Valenzuela, Arriagada, & Scherman, 2012), which positively correlate Internet use with different forms of political participation, we tracked Facebook and Twitter streams related to the aforementioned protests. Although these movements have sought to congregate and take action in physical spaces (Castells, 2012), a linear relationship from digital communication to onsite activity has been reported by scholarship discussing their spread (Tremayne, 2014; Vasi & Suh, 2013) and ranks (Anduiza, Cristancho, & Sabucedo, 2013, p. 10). In our

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turn, we seek to move this scholarship forward by probing for evidence of any elapsing connection between network communication and on onsite events occurring in the course of collective action.

The first of the three case studies was the Spanish demonstrations that started in Madrid on 15 May 2011 as a protest against welfare cuts, the political establishment, and the runaway financial system (Castells, 2012). At the end of the initial demonstration, protestors blocked a major avenue in Madrid and subsequently clashed with the police. After that violent incident, a group of 100 protestors headed to Puerta del Sol, the city's main square, where overnight camping was organized. During the next few days, the protests and night-time camp-outs spread to more than 30 cities across Spain. The Occupy protests, our second case study, started on 17 September 2011 when Adbusters launched the proposal for a peaceful demonstration to "occupy" the global financial center at Wall Street (Moynihan, 2011). An estimated 1,000 people attended the first day of the protest, reportedly inspired by the Spanish uprisings and the events of the "Arab Spring." On 23 September, demonstrators began camping in Zuccotti Park. The following day, demonstrations intensified when protestors marched uptown and instances of police brutality were broadcast on YouTube and television news programs. Subsequently, the Occupy movement spread to cities across the United States. On 15 October, 1 month before New York protestors were forced out of Zuccotti Park, similar demonstrations had happened in 951 cities in 82 countries.

The third and last case study is that of the Vinegar protests in Brazil. The social unrest was initially sparked by opposition to bus and underground fare rises in June 2013. However, the target of contention rapidly shifted onto the running costs of infrastructure projects associated with international sport events, such as the Confederations Cup, the World Cup, and the Summer Olympics (Singer, 2014). Protestors raised conflicting demands encapsulated in concomitant calls for improvements in public services, lower taxation, and expanded welfare benefits. The first large protest was held at the beginning of June, and on 17 June, an estimated 250,000 protestors took to the streets of major cities across the country. Protest marches turned violent and urban riots ensued in a number of Brazilian cities. The demonstrations were subsequently dubbed Vinegar in reference to the 60 protestors arrested for carrying vinegar allegedly used as an antidote to the tear gas and pepper spray deployed by the police.

In what follows, we set the theoretical groundwork for our investigation by mapping the immediate field of research. To that end, we reflect on key empirical findings and attendant claims that motivated this study. The subsequent two sections are dedicated to describing the procedures for data collection and aggregation as well as the method employed for the time-series analysis. In the final two sections, we present the results and discuss the implications of our findings to theories of political protest.

Previous work

Despite the growing amount of empirical research on network communication linked to physical protests (Borge-Holthoefer et al., 2011; Gaffney, 2010; González-Bailón,

Borge-Holthoefer, Rivero, & Moreno, 2011; Kavanaugh, Yang, Li, & Ed Fox, 2011), and a large body of literature proposing competing accounts about contentious communication (Bennett & Segerberg, 2013; Morozov, 2011), the impact of networked communication on onsite protesting activity remains to be conclusively evidenced. This debate has ranged from the argument that innovative modes of mobilization, organization, and collective action are generated with social media (Howard & Hussain, 2013) to the counterclaim that digital activism has no bite as aggrieved populations confine their outrage to the computer screen (Morozov, 2011).

Yet, the tactical deployment of digital communications by activists has been portrayed as an upscaling of interest and participation in contentious politics (Earl & Kimport, 2011, pp. 10–14; Lim, 2013; Valenzuela, 2013). What such research on contentious politics has so far done less rigorously (Earl, McKee Hurwitz, Mejia Mesinas, Tolan, & Arlotti, 2013) has been to employ tried instruments such as statistical tests and time-series analyses to verify the direction and effect between online communication and onsite protest. Indeed, while there is growing convergence in the knowledge that networked communication on social media is germane to protest participation (Howard & Hussain, 2013; Valenzuela, 2013), interactions between social media usage and onsite activities have mainly been the object of sample-based quantitative content analyses (Earl et al., 2013) or ethnographic observations (Gerbaudo, 2012). Moreover, the prevalent interest in those accounts has rested with ascertaining types of communication behavior conducive to political protest (e.g., using social media for news consumption) or embodied in political protests—for example, tweeting hashtagged action updates or expressing emotional support (Bastos, Raimundo, & Travitzki, 2013).

There are notable recent attempts to measure the influence of online activism on the spread of offline protests (Bastos, Recuero, & Zago, 2014; Jungherr & Jürgens, 2013; Vasi & Suh, 2013). Vasi and Suh (2013) applied event history analysis to Internet search and social media data related to the Occupy Wall Street movement. The authors reported that Internet searches had a direct influence on the emergence of online activism and an indirect influence on the spread of onsite protests. Facebook and Twitter information streams were also found to positively affect the spread of offline protests over time, while cities that experienced online activism were also likely to experience actual occupations. This article complements and extends this treatment by proposing to untangle the relationship between certain forms of onsite activity (e.g., camping out) and networked communication pertaining to it. Specifically, the question we seek to address with this article is whether the protests of the Indignados, Occupy, and Vinegar movements were followed by commensurate Facebook and Twitter activity; whether they evolved coextensively by exhibiting bidirectional determination (feedback) between onsite and online protest activity, or finally, whether the networked communication on Twitter and Facebook had any bearing on developments at the street protests.

Protest diffusion: a tale of linking paths

A key reference point for this undertaking has been the literature on protest diffusion. The outbreak of protest has been documented extensively as a contagious occurrence over space and time (Montagna, 2010; Tarrow, 2005, 2011). In Lichbach's (1985) seminal time-series study of political protests, the hypothesis of a random occurrence of protest was rejected as in postwar United Kingdom protest erupted following a concerted build-up over time. Protests occurred in a process of contagion and diffusion of ideas and behaviors that amplified and sustained collective action (Givan, Soule, & Roberts, 2010).

Although the literature on the diffusion of contention is sizeable, it has by and large been restricted to a focus on traditional channels of communication between prior and potential sites of contention (Vasi & Suh, 2013). To tackle our aim of disentangling the intricate relationship between onsite activity and networked communication, we consequently turned to studies of message diffusion about real-world phenomena on social media (Kallus, 2014; Ko, Kwon, Kim, Lee, & Choi, 2014; Russell Neuman, Guggenheim, Mo Jang, & Bae, 2014). Groshek (2011) performed Granger-causality tests on cross-national time-series data to investigate the effects of broadcast media on democratic growth and reported that mass media diffusion Granger-caused democracy only in countries where sociopolitical instability levels were higher and mass media were more prevalent. Yamaguchi et al. (2013) investigated the impact of Twitter messages and internet forums on a signature-collecting campaign supporting traditional Japanese medicine. The authors reported that 78% of the signatures were affected by online activity and that the Twitter effect was smaller than the Internet forum (26 and 52%, respectively), although Twitter probably triggered the initial bursts of signatures (Yamaguchi et al., 2013).

Following a similar interest, Jungherr and Jürgens (2013) examined variations in online data to detect traces of offline phenomena. The authors measured recurrent dynamics of online data and argued that information deliberately published by users on social networking and microblogging services enables the documentation of user activity online as well as in their physical surroundings, as long as the latter are referenced or traceable to a physical location with metadata (Jungherr & Jürgens, 2013, p. 596). In particular, these may be purposeful reports of embodied action representing, inter alia, the real-time coverage of law enforcement activity at the site of a protest (Earl et al., 2013; Gerbaudo, 2012), a well-documented activity undertaken for its potential to fan the flames of contention (Tarrow, 1998), or communication relating to protest tactics (Theocharis, 2013).

Research hypotheses

Cognate research has shown that both Twitter and Facebook activity were strongly associated with police–protestor interactions (Caren & Gaby, 2011), such as the arrest of more than 100 protestors at the Occupy Boston encampment on the evening of 10 October 2011 and the detention of 23 people at the Occupy Denver encampment on 14 October. In the run up to this analysis, we noted that Twitter hashtag activity linked to

the Occupy movement peaked on 1 October, when over 700 individuals were arrested on the Brooklyn Bridge, and on 15 October, when hundreds of simultaneous protests were held around the globe. This is in line with Caren and Gaby (2011) and Earl et al.'s (2013) assessment that both Twitter and Facebook streams were strongly connected to onsite events. However, those authors did not produce a systematic analysis of this relationship, nor did they evaluate multiple instances of political unrest.

In order to test the relevance of the above insights for protest diffusion, the present analysis foregrounds the question of the directionality of a causal link between digital communication on social media and physical protest. Therefore, our primary objective was to scrutinize the interactions between online and onsite activities within the timeframe of the three instances of political upheaval. To this end, we tested the hypothesis that the outbreak of online protest activity at one point in time can be used for prediction of future outbreak of onsite protest activity (H1a), so that the temporal diffusion of protest-related networked communication may contribute to the onset of onsite protests. Conversely, networked communication may only bear on onsite activity indirectly, as a nonrelational mechanism that at best ripples through communication networks generating a self-referential digital echo inconsequential to physical participation (H1b).

If the latter postulate stands in contrast to earlier studies (Fisher & Boekkooi, 2010; Tufekci & Wilson, 2012), this may be attributable to differences in (a) the nature of empirical data and (b) the levels of analysis. To briefly unpack these points, the two referenced articles relied on self-reported user behavior captured either with quantitative or qualitative interviews whereas the present analysis draws on aggregated "big data," which are large datasets of digital data employed to identify behavioral patterns. Second, and as an effect of the divergent data sources, this investigation departs from those previous treatments in that it does not generalize collective behavior from individual conduct. Instead, we cross-check media accounts of collective behavior in onsite protest with large datasets of contentious networked communication (Colbaugh & Glass, 2012; Lerman, Galstyan, Ver Steeg, & Hogg, 2011). In this, our study builds on the methodological tradition of protest event analysis (Koopmans & Rucht, 2002) and our methods, as discussed more extensively below, draw on press reports of protests to map, analyze, and interpret their occurrence over time (Koopmans & Rucht, 2002).

Our second objective has been informed by Manuel Castells' (2012) chronicle of the Indignados demonstrations. Castells remarked that Twitter was instrumental to the establishment of encampments in key locations such as at Puerta del Sol in Madrid or in Catalunya Square in Barcelona. In his turn, Castells (2012) highlighted the fundamental part that onsite interaction between law enforcement and protestors played in the fate of that contentious action as well as in the networked communication around it. Taking this cue, we examined social media streams not only against accounts of the number of protestors attending demonstrations, but also against the number of protestors setting up or taking down protest encampments, and the number of protestors injured or arrested by the police during the three

instances of political unrest. We designated those involved in such strenuous action as high-functioning political activists (Bobel, 2007). We hypothesized a Granger causality from the intensity of social media communication to high-functioning political activism measured by police and encampment activity (H2a), and from high-functioning political activism to the intensity of social media communication (H2b).

Last, Earl et al. (2013) contended that Facebook activity tends to be high in the run-up to a physical protest (when used to rally participants) and in the aftermath (when used as an arena for *post hoc* reflection on the protest). By contrast, Twitter usage was argued to coincide with onsite action and on-the-ground coordination of protests (Earl et al., 2013). The third objective was therefore to elucidate the relationship between the social networking sites Twitter and Facebook during the three instances of political unrest by employing the Granger-causality test to forecast the intensity and directionality between tweets and Facebook posts. Specifically, we hypothesized that in the course of the protests Facebook pages impacted the activity of Twitter streams (H3a). However, the opposite relationship might also hold true due to the use of Twitter for streaming the events as they unfold (H3b). Finally, we tested the Granger-causality hypotheses in both directions for the pairs of variables and reported feedback when the results confirmed bidirectional Granger causality between the variables.

Research data

We tracked around 100 Twitter hashtags associated with the Indignados, Occupy, and Vinegar protests (roughly 35 hashtags per event) and another 100 Facebook pages and groups dedicated to the events (see the Appendix for the list of Twitter hashtags and Facebook pages). While the Indignados dataset encompasses political demonstrations that took place in Spain in May 2011, the Occupy dataset includes a number of locations in the United States and major cities across the world (i.e., Amsterdam, Berlin, Dublin, Frankfurt, London, Paris, Tokyo, and Toronto). Given the purpose of this investigation, we focused on information streams associated with cities rather than conceptual tags such as #nolesvotes (*don't vote for them*) and #notenemosmiedo (*we are not afraid*) in the Indignados dataset; #occupytheworld and #occupytogether in the Occupy dataset; and #vemprarua (*take to the streets*) and *#todarevolucaocomeca* (*every revolution begins with*) in the Vinegar dataset. The rationale for this procedure was rooted in the anticipation that activity on city-related hashtags and Facebook groups, unlike conceptual tags, would more closely relate to onsite demonstrations (Thorson et al., 2013).

The reported Twitter data were collected from the publicly available Twitter stream. It was retrieved with an authenticated user account running yourTwapperKeeper (O'Brien, 2010) that connected to the Twitter Streaming Application Programming Interface (API). Private user information was excluded from the analysis, which was run solely based on the unique identification of each tweet and Facebook post rather than usernames. We expect the selection of Twitter hashtags

to have rendered a representative, if biased (Morstatter, Pfeffer, Liu, & Carley, 2013), sample of the full stream because the data requested for this analysis are well below the 1% threshold of the entire public stream allowed by the Twitter Streaming API (Driscoll & Walker, 2014). The Facebook Graph API imposes no such limits, so the data were collected via a series of requests on the API. Therefore, and unlike the Twitter data gathered for this study, Facebook posts and the number of protestors attending demonstration were collected at the end of the research period.

Facebook and Twitter data for the Vinegar protests were gathered from their very onset. Data collection for the Indignados dataset started on 17–19 May, and although the movement generally peaked only on 19 June, the first mass mobilizations in Madrid had already begun on 15 May. In addition, while half the Occupy dataset includes the entire period of the demonstrations, the other half presents an average delay of 12 days.[1] Even though the Occupy protests peaked as early as 1 October, the movement as a whole climaxed on 15 October when simultaneous events were held in many countries. We believe these small delays in the archiving processes do not affect the results reported in this study, mostly because the movements grew in popularity and scope after the first demonstrations (Bastos et al., 2014; Caren & Gaby, 2011; González-Bailón et al., 2011). Furthermore, our methodology focuses on the distribution of protest activity at different points in time, so shortfalls at the beginning or the end of the period should be of minor effect to the time-series analyses (Bressler & Seth, 2011).

Data relating to the number of protestors attending demonstrations or camp-outs at protest locations, as well as data on the number of protestors injured or arrested by the police, were collected from press reports about the episodes (see the Appendix for a table with the number of reports collected from each outlet). This approach was grounded in the protest event analysis tradition, which draws on newspaper articles on a contentious gathering (e.g., demonstrations, marches, or strikes) as the main unit of analysis. Without making claims to the representativity of the data for a universe of protest events, the method enables the collection and cross validation of media accounts to determine the number of participants at protest events (Koopmans & Rucht, 2002). Other information of interest to the research may be gathered at the same time (Koopmans & Rucht, 2002) and was duly recorded here, that is the number of protestors and individuals camped-out, injured, or arrested while attending the demonstrations.

Reports from media outlets accounting for the number of protestors attending or camping out at protest locations were often found to be conflicting. When the figures reported in multiple press accounts differed substantially, we calculated the mean of all numbers provided by the press. Whenever media reports failed to produce unambiguous information regarding the number of arrested protests attending Occupy demonstrations, we reverted to relevant information issued by the Occupy Arrests organization (Ernesto, 2011). The resulting dataset comprises the number of tweets, Facebook posts, and protestors engaged in political activities associated with demonstrations in the cities where protests took place. Table 1 shows the summary

Table 1 Parameter Estimates for Daily Data of Indignados, Occupy, and Vinegar

		Date	Tweets	Posts	Protestors	Camped-out	Arrests
Indignados	Min	17 May 2011	1,944	772	25	50	3
	Median	NA	11,024	3,356	2,000	425	5
	Mean	NA	27,012	4,177	15,877	882	9
	Max	29 June 2011	198,095	12,647	212,000	4,775	26
	SD	NA	45,766	2,766	40,921	1,416	9
	NAs	0	0	0	14	34	39
Occupy	Min	24 September 2011	2,271	3,469	1	NA	1
	Median	NA	74,007	13,393	1,900	NA	31
	Mean	NA	86,265	15,727	6,724	NA	82
	Max	29 December 2011	414,408	47,431	56,200	NA	724
	SD	NA	67,973	8,533	13,490	NA	143
	NAs	0	0	0	46	NA	18
Vinegar	Min	13 June 2013	8,525	57,860	4,000	1	3
	Median	NA	20,696	239,827	52,500	4	31
	Mean	NA	61,746	253,166	204,046	32	59
	Max	29 June 2013	294,257	573,286	1,569,150	100	325
	SD	NA	91,445	127,050	423,983	45	97
	NAs	0	0	0	4	11	7

statistics of Indignados, Occupy, and Vinegar and indicates the minimum, maximum, median, mean, and standard deviation of the dataset.

There are some asymmetries relating to the data available for each instance of political unrest. First, the Occupy series does not include the number of injuries. We also have not found consistent and reliable sources of information regarding the number of camped-out and injured protestors in the cities that experienced Occupy movements. Second, the Indignados is the only series that includes data about camped-out protestors. Third, Vinegar is the only series that contains data about protestors injured during demonstrations. These differences did not preclude our analyses as all series included a minimum of two variables of online protest activity (tweets and Facebook posts) and two variables of onsite protest activity, the first being the number of protestors onsite and the second being the number of protestors arrested during demonstrations. This latter variable relates to high-functioning political activism, and whenever available we also tested a fifth variable associated with high-functioning political activism (protestors camping out or injured during demonstrations).

At first call, we found that onsite activity was sparse, intermittent, and seldom spanned the entire period of the analysis. We addressed this shortcoming by aggregating the variables for protest activity online and onsite by city (i.e., Madrid, New York, or São Paulo) and subsequently creating single datasets for the Indignados, Occupy, and Vinegar protests. This approach allowed for the creation of a complete series associated with each instance of political arrest because the observations were

first aggregated by geographic location and subsequently by the overarching political movement. In order to control for the highly skewed pattern of protest activity online and onsite, and the different locations where events took place, we only aggregated data for cities that experienced protesting activity onsite and online (on Twitter and Facebook), so venues with high activity online but no activity onsite (or vice-versa) were not included in the aggregated data. This empirical observation is corroborated by the distinction between hyper-local and the network communication embedded in ground-level activity within the Occupy movement (Bennett, Segerberg, & Walker, 2014). We took this point as a cautionary note regarding the gamut of local operations which a design such as ours can capture, as much ground-level activity does not register in the network communication.

Our processed data thus include the daily number of tweets, Facebook posts, protestors, and high-functioning political activists attending street demonstrations (see the Appendix for the breakdown of the variables considered). Figure 1 shows a histogram of Twitter, Facebook, and protesting activity in logarithmic scale for the three instances of political unrest. The bar charts on the left show the daily aggregated data, and the plot on the right summarizes the hourly aggregated data for each event.

Research methods

In order to measure predictive causal connectivity across the instances of political unrest, we modeled the data as stochastic time series and performed a Granger-causality test. Originally developed for economic time-series data by Wiener (1956) and Granger (1969), and since then applied to time-series data of many different domains, the Granger-causality test offers a data-driven, theoretically sound, and easy to apply statistical time series approach to causal inference based on prediction (Bressler & Seth, 2011; Schelter, Winterhalder, & Timmer, 2006). The null hypothesis of no Granger causality is rejected only if no lagged values of the explanatory variable have been retained in the regression. Yet, Granger-causation is only equivalent to causation under the assumption that there are no other potential causes.[2] This is the first attempt to apply the Granger-causality test to this type of series, and in this study, we tested the two-way, paired relationship between six numeric variables, namely: tweets, posts, protestors, camped-out, arrested, and injured protestors.

The assumption underlying the Granger-causality test is that the explanatory variable Granger-causes the outcome variable whenever there is a nonexpected output that leads to an increase in the outcome variable. This framework states that a process X is considered a cause of another process Y if the knowledge about the past of X significantly improves the prediction of the future of Y, as opposed to the prediction based only on the knowledge about the past of Y. Notably, our variables of interest relate to complex social events that might impose violations to the abovementioned assumption of noncompeting causes. However, we are convinced of the appositeness of the Granger-causality test for our data. This is because the method enabled testing the extent to which the past of protest-related online activity contains information that

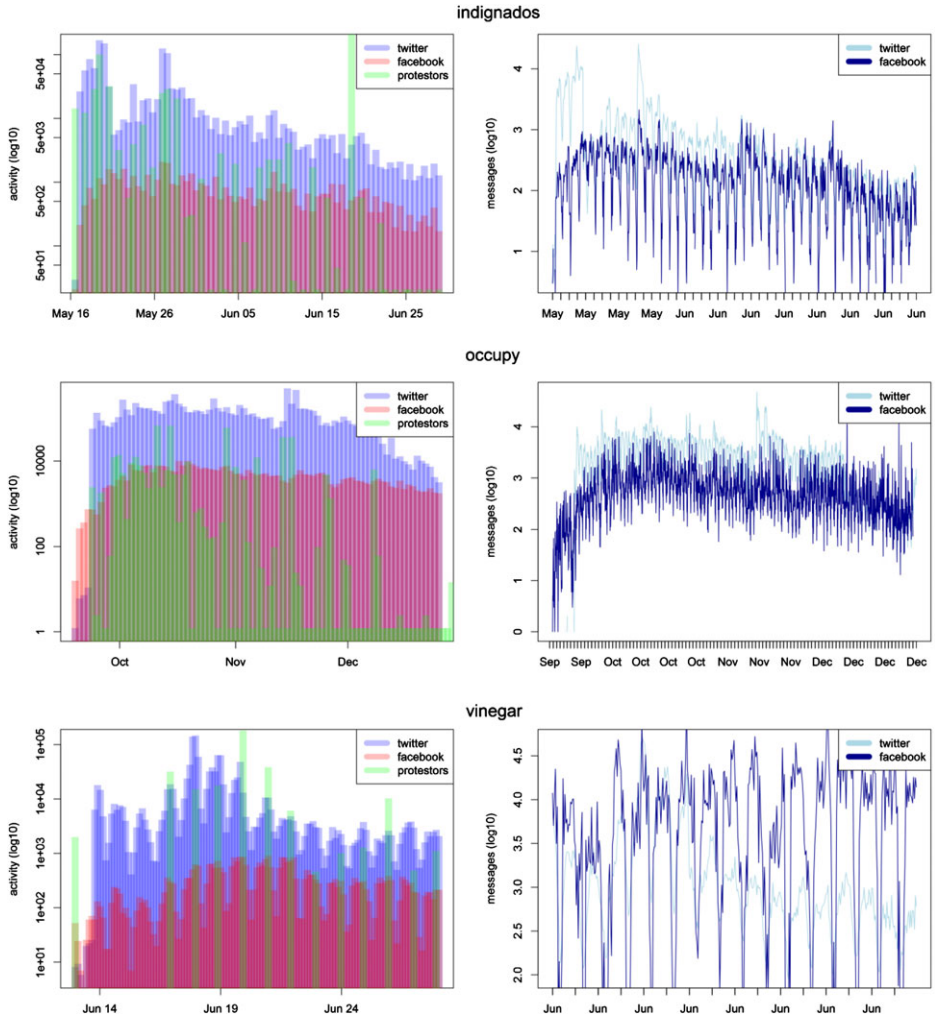

Figure 1 Histogram of Twitter, Facebook, and protest activity (left) and plot of the hourly aggregated data of Twitter and Facebook (right).

helps predict the future of onsite protest activity (and the other way around) more accurately than using only the past of one of the variables. Translated to the events studied in this article, we propose political messages on social media Granger-cause onsite activity if social media spikes are followed by a corresponding increase in the volume of protestors attending onsite demonstrations, so that online protest activity Granger-causes onsite protest activity.

In order to perform the pairwise Granger-causality test for the time series, we relied on the R platform for statistical computing (R Development Core Team, 2014) and performed a vector autoregression (VAR) lag order selection criteria to choose the best lag length for the VAR time-series model (Schwarz, 1978; Tschernig & Yang,

2000). We decided to adopt VARs of order 1[3] to avoid misinterpreting the results. When dealing with causality for higher order VARs, it is difficult to analyze the causality implied by the lag. For instance, a causality with a VAR(3) means that there could be a causality effect tomorrow, the day after tomorrow, or even the day after that without allowing for conclusions on the lag. Moreover, for a vast majority of pairs, order 1 is the optimal order for an AIC criteria procedure *VARselect* (Lütkepohl, 2007).[4] Therefore, the results reported in this article are based on a VAR(1) model and the noncausality reported in the analyses should be understood as noncausality from one day to the next day. Twitter and Facebook data are highly skewed with heavy tails considerably affecting the estimation of correlation (i.e., autocorrelation). In such cases extreme variations might appear correlated due to tail, but not to regular dependence. In order to reject causal effects due to the skewed distribution of the series, and seeing that the Granger-causality test assumes a bivariate Gaussian distribution, we relied on a semiparametric transformation to correct from the nonnormality of the individual time series (Sanggyun & Brown, 2010).

A pure nonparametric transformation was considered in Hiemstra and Jones (1994) with a formal testing procedure. In fact, it is possible to consider a semiparametric transformation to obtain individual Gaussian time series (Eichler, 2010). This approach was discussed by Liu, Lafferty, and Wasserman (2009) and Liu, Bahadori, and Li (2012) as a method to assess causality between two time series i and j. The method is based on the following procedure: For time series i, find an empirical marginal distribution function based on the ranks $\widehat{F}_i$ and $\widehat{F}_j$, $\widehat{F}_i(x) = \frac{1}{T+1}\sum_{t=1}^{T} 1\left(X_{i,t} \leq x\right)$, and similarly for j, and subsequently map the observation into the [0,1] copula space (Taamouti, Bouezmarni, & El Ghouch, 2014), $\widehat{U}_{i,t} = \widehat{F}_i\left(X_{i,t}\right)$ and $\widehat{U}_{j,t} = \widehat{F}_i\left(X_{j,t}\right)$. Finally, we define $\widetilde{X}_{i,t} = \Phi^{-1}\left(\widetilde{U}_{j,t}\right)$ and perform standard Granger-causality tests on permutations of pairs of online and onsite protest activity $\left(\widetilde{X}_{i,t}, \widetilde{X}_{j,t}\right)$. We considered pairwise causality to avoid misinterpretation—that is, the extension of Granger's bivariate causality on VAR to higher dimensions as discussed extensively in the statistical literature (Granger & Lin, 1995; Jea, Lin, & Su, 2005; Lin, 2007).

Results

The first of our Granger-causality tests was performed in order to determine if protest-related social media activity on Twitter and Facebook provided significant information for forecasting protest-related onsite activity during the Indignados in Spain, the Occupy, and the Vinegar protests in Brazil.[5] Figure 2 shows the results of the Granger-causality test across the three instances of political unrest with the F-statistic and p values between the pairwise variables. The test statistic in Figure 2 is colored in a gradient heat map, with significant test statistics displayed in white boxes. The results indicate that online communication on Twitter and Facebook predicted onsite protest activity in the Indignados ($p < .00$ and $p < .01$, respectively) and the Occupy datasets ($p < .00$ and $p < .00$, respectively), with bidirectional Granger

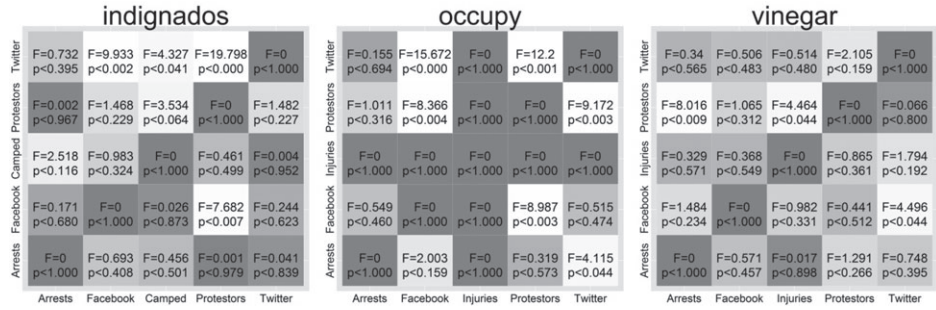

Figure 2 *F*-statistic and *p* values of Granger-causality test between the variables (predictors on vertical and predicted on horizontal axis).

causality between online and onsite protest activity in the Occupy series ($p < .00$ for all pairwise variables). In the case of the Vinegar protests, the direction of the prediction was only from online to online and onsite to onsite variables—from Facebook to Twitter ($p < .04$) and from protestors to injuries and arrests ($p < .04$ and $p < .01$, respectively). Finally, the results of the Granger test for lag 1 indicated that tweets Granger-caused Facebook posts in the Indignados and the Occupy series ($p < .00$ for both variables).

Next we relied on arrests and camped-out protestors as measures of high-functioning political activism to test H2. We found Granger causality between online and onsite protest activity in the Indignados series, as tweets Granger-caused camped-out protestors, and in the Occupy series, as arrests Granger-caused tweets ($p < .05$ for both variables). The results indicate that the Granger causality between online and onsite protest activity varies considerably across the individual instances of political unrest. While the online and onsite series in the Vinegar dataset evolved mostly self-referentially, the online and onsite series in the Occupy dataset presented a significant level of feedback, with Twitter and Facebook both predicting and being predicted by protestors attending demonstrations onsite.

The Granger-causality tests for the Indignados dataset, on the other hand, pointed to a one-way relationship from online to onsite protest activity, with both Twitter and Facebook predicting protests and Twitter also predicting campouts. These patterned Granger-causalities observed in Figure 2 also shed light on different adoptions of social media platforms and enables us to reflect on H3. The pivotal role played by Twitter for the coordination of local logistics, particularly in the organization of encampments in the Indignados movement, or acting as a live feed among U.S. occupiers (Castells, 2012, p. 172), is consistent with the results shown in Figure 2. In fact, the Indignados and the Occupy series suggest that one could forecast onsite protests by monitoring the use of Twitter, and, to a lesser extent, of Facebook posts. Vinegar is the only series where the Granger-causality test yielded no significant results for the relationship between online and onsite protest, with statistically significant predictions only within online and onsite activity, but not

Table 2 Statistically Significant Granger-Causality Relationships Between Onsite and Online Protest Activity

	From		To	*p* value	*F*-statistic
Indignados	Facebook	→	Protestors	0.006935	7.681863265
	Twitter	→	Camped-out	0.040705	4.327367764
	Twitter	→	Facebook	0.002285	9.932696869
	Twitter	→	Protestors	0.000028	19.79784760
Occupy	Arrests	→	Twitter	0.043938	4.114710565
	Facebook	→	Protestors	0.003091	8.986728723
	Protestors	→	Facebook	0.004278	8.366341747
	Protestors	→	Twitter	0.002806	9.172262406
	Twitter	→	Facebook	0.000107	15.67231216
	Twitter	→	Protestors	0.000597	12.20012279
Vinegar	Facebook	→	Twitter	0.043679	4.495825716
	Protestors	→	Arrests	0.008828	8.016421032
	Protestors	→	Injuries	0.044385	4.463507130

across the two modalities of protest activity. Table 2 provides a breakdown of the Granger-causality tests and displays only significant results with *p* value and the *F*-statistic.

First, the results were consistent with H1a for the Indignados and the Occupy series, as the outbreak of online protest activity contains information that helps predict the future of onsite protest activity. We therefore rejected H1b and concluded that contentious communication is Granger-causal of physical participation in demonstrations. In the Occupy series, we also found bidirectional Granger causality between online and onsite protest activity, thus further confirming H1a and thereby rejecting the hypothesis that online communication is inconsequential to onsite protest activity (H1b). Second, hypotheses H2a and H2b were both partially confirmed, as tweets were found to be Granger-causal of camped-out activity in the Indignados series and arrests Granger-caused tweets in the Occupy series. Likewise, protest activity was found to Granger-cause high-functioning political activity in the Vinegar series, as the increase of protesting activity predicts clashes with the police measured by arrested and injured Vinegar protestors.

Third, hypothesis H3b was confirmed in the Indignados and the Occupy series. In that instance, tweets Granger-caused Facebook posts with highly significant *p* values. Nonetheless, hypothesis H3a could not be rejected, as Facebook posts were found to Granger-cause tweets in the Vinegar series. Embedding these findings back into their context, we interpret the partial confirmation of hypotheses H2 and H3 as further evidence that political activists relied on social media platforms, and arguably successfully, to organize rallies and encampments (camp-outs), particularly in the Indignados and the Occupy series. Moreover, we note that the streaming of incidents of police harassment and/or police brutality (arrests and injuries) during the Occupy protests

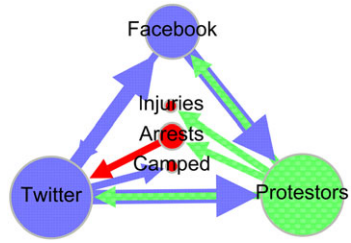

Figure 3 Directionality of Granger-causality between tweets, Facebook posts, and camped-out, injured, and arrested protestors that participated in demonstrations (all three instances of political unrest considered).

had immediate impact on social media and looped back on demonstrations onsite (Castells, 2012; Earl et al., 2013).

Notwithstanding the abovementioned caveats, the results of the Granger-causality test lend some verification to the claim that online activity can predict onsite activity. Except for the Vinegar series, protesting activity was found to be predictive of multiple instances of social media activity in the Indignados and Occupy series. Moreover, we also found evidence of onsite protest activity predicting online activity in the Occupy series with highly significant *p* values both for Twitter and Facebook streams. Figure 3 shows the direction of Granger-causalities across the instances of political protest considered in this study, with social media activity depicted in blue, high-functioning political activism shown in red, and onsite protest activity colored green.

Last, we note that the results of the Granger-causality test were only used to assess the direction of the predictive relationship between online and onsite protest activity. In this sense, we argue that Twitter and Facebook activity observed during the political events considered in this study are informative of (and consequently forecast) next day's protest activity. Our results thereby indicate that the increase of protest-related communication on social media can be a means to forecast onsite protest activity.

Discussion and further research

The Indignados, Occupy, and Vinegar political protests were largely organized by grassroots activists working in central city locations over weeks or months. These political movements operated in a horizontal, consensus-based decision-making mode enacted in assembly meetings in which face-to-face interaction was the primary means of communication and a central platform for advocating participatory democracy (Mercea, Nixon, & Funk, 2013). On the other hand, these movements also relied on social media to recruit participants and enhance mobilization (González-Bailón et al., 2011), resulting in a great deal of discussion about the extent to which social media aid in igniting popular protests (Gerbaudo, 2012). In this article, we tested this hypothesis and found compelling evidence that online protest activity is informative of and forecasts onsite protest activity across multiple

instances of political unrest. In the remainder, we consider the wider implications of these findings.

We have shown that in the case of the Occupy movement there was a feedback in the prediction of online and onsite protest activity (both on Twitter and Facebook); that in the case of the Indignados movement networked communication was predictive of onsite protest activity (both on Twitter and Facebook); and that the Vinegar protests presented no Granger causality from online to onsite protest activity. Instead there were online to online interaction (from Twitter to Facebook) and from onsite to onsite protest activity (protestors to injuries and arrests). In short, in two of the three cases, we found significant Granger causality from Twitter and Facebook protest activity to demonstrations onsite and from physical protests to social media platforms, thus establishing a feedback loop from social media activity to onsite protests and back to social media.

For the reasons outlined above, we view these findings as an initial and limited confirmation by way of a large-scale cross-national study that online and onsite protest activity can be used for mutual predictions (Earl et al., 2013; Fisher & Boekkooi, 2010; Tufekci & Wilson, 2012). Moreover, on the basis of the Indignados and the Occupy evidence, we would submit as a basis for further testing the claim that the outbreak of onsite protest activity can be forecasted by related streams of information on Twitter and Facebook. Consequently, we would propose that wider comparative inquiries verify whether the increase of political messages on social media associated with a specific protest movement constitutes a fertile basis for forecasting the direction of future activity in the same political movement.

In view of the Granger-causalities observed in this study, and recognizing the contextual variability that may further bear on the relationship between online and onsite protest activity, Twitter and Facebook are likely to have amplified demonstrations through continuous networked communication that feeds into the process of participant recruitment. This is a contentious assertion as it stands at odds with claims of political disengagement and the ineffectiveness of social media communication in promoting onsite protest participation, a presumed state of affairs derided as "slacktivism" (Morozov, 2011).

The results of the Indignados series showed that we can expect more protestors attending demonstrations whenever there is a rise in the number of messages related to the demonstrations on Twitter and Facebook. This directional relationship from social media communication to demonstrations may be difficult to grasp if one expects the staging of demonstrations to trigger communication on Twitter and Facebook; or, in the context of the rising penetration of mobile internet technologies, if one anticipates social media communication to be predominantly driven by the reporting of onsite activity (Earl et al., 2013). With this analysis, we believe we may aid with the systematic substantiation of the notion that social media may be a central component of the panoply of tools for organizing and publicizing protest activities before they take place. In addition, the test of the Occupy series also revealed significant feedback between online and onsite protest activity, likely sustained by

different affordances of Facebook and Twitter. While the former is used as a forum for group-bounded interaction where the general public has limited to no access, Twitter streams are notoriously open, easy to monitor, and may be preferred for real-time or *post hoc* announcements of protest actions. Nonetheless, the results remain silent about the negotiation of social media usage at the levels of groups and individual protestors who may calibrate it in light of recognized threats intrinsic to social media communication such as surveillance (Mercea, 2012).

Our findings are supported by the image of a vast media ecology, which spawned around the Occupy protests and that integrates broadcast and social media in global hubs of communication. Elsewhere, it was posited that social media were entwined in a dense, multilayered matrix of *stitching mechanisms* (Bennett et al., 2014) that testifies to the enmeshment of online and onsite activities. The latter contributed to the organization of activist groups in disparate geographic locations by facilitating the syndicated creation and coordination, the deployment of resources, and the strategies or meanings utilized in the protests. Nonetheless, as already argued, such ostensible symbiosis was in no way complete and immutable, with many onsite activities not being chronicled online and networked communication simultaneously acting as a bridge for emotional support or political deliberation across protest sites (Mercea et al., 2013). The results from the Indignados series appeared consistent with this description. Findings for the Vinegar protest, while requiring further in-depth qualification, allude to a dissimilar balance between local and hyper-local communication and highlight the existence of alternative media ecologies lacking effective integration between broadcast and social media (Saad-Filho, 2013). Last, the bidirectional Granger causality in the Occupy series provides evidence to the claim that political constituents are becoming increasingly connected as individuals rather than as members of a community or group (Bennett & Segerberg, 2013; Flanagin, Stohl, & Bimber, 2006).

In making these claims, we nevertheless highlight that Facebook data collected for this study are restricted to updates posted on the stream of pages, groups, and communities associated with the political movements (see the Appendix for the full list of Twitter hashtags and Facebook groups and pages), consequently encompassing only content made available on Facebook's public stream. Second, Twitter and Facebook user bases (Pew Research Center, 2012, 2013) are most likely not representative of the demographics of citizens that engaged in political demonstrations during the Indignados, Occupy, and Vinegar protests. Therefore, the present results pertain to a publicly active contingent of social media users that communicated about the protests rather than the population at large.

It must also be noted that even though we compiled the data by number of tweets, posts, and protestors posting messages and attending demonstrations in the cities where demonstrations took place, the analysis reported in this article is based upon daily aggregate data per event (Indignados, Occupy, and Vinegar). The Granger-causality test requires a long-time series, and the data aggregated per city where events took place did not provide a sufficient number of time points as required

for the test. In other words, each instance of political unrest was aggregated over all spatial locations instead of their regional disaggregations. This kind of aggregation is customary in the literature on time-series analysis when the aim is to show temporal variations in events at the macrolevel that transcend individual instances of multisite protest events. Lichbach (1985, p. 589) commented that although protest results from the actions of specific actors acting at specific times, in specific places, and in distinctive ways, the empirical study of protest over time cannot be quite so microscopic. Instead, it inevitably relies on information gleaned from reports about the episodes, usually taken from journalistic sources. With this in mind, we claim that although perfectible to better account for contextual variability, our approach is appropriate to these series. We also highlight that if the interplay between onsite and online protest activity could be investigated at more disaggregated levels—such as city or neighborhood level—more significant relationships would probably be unveiled. Further research drawing on more detailed data is necessary to determine the relative strategies of social media users in reference to instances of political unrest.

In the last instance, this study should aid with further untangling the interplay between online and onsite protest activity. Principally, it has enabled us to look beyond the vexing debate of whether social media activity has caused political unrest in the past 5 years, or whether social upheaval gave the tone to social media communication. In short, the reported findings provide substantive grounds to move beyond an "either or" view toward an integrated approach spanning both dimensions of time and space to account for the networked communication of political unrest in the 21st century. By showing that the Granger causality between online and onsite contentious actions varies considerably across different instances of political unrest, we have provided the necessary empirical baseline to move cognate scientific debates beyond predominant questions of directionality and onto questions of magnitude of mutual elapsed effects of onsite activity and related networked communication.

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Notes

1 The average delay is relative to 17 September 2011 when Adbusters launched the proposal to occupy Wall Street. Most Occupy movements are offshoots of the seminal "Occupy Wall Street," and therefore occurred after this initial event.

2 Granger causality is nonetheless useful for forecasting synchronous events even in the presence of unknown causes—that is, the tested variables X and Y are influenced by variable Z that is not supported by the data. In this case, we might conclude that Y

Granger-causes X, although X might actually be driven by the influence of Z over Y and subsequently over X. Translated to the cases studied in this paper, it is possible that press coverage of onsite protests influenced social media that later influenced onsite protests, but the test measures only the Granger-causality between social media and onsite protest activity. Nonetheless, we expect the results of the test to quantify the extent to which the past of protest-related social media activity contains information that helps predict the future of onsite protest activity (and the other way around) more accurately than using only the past of one of the variables.

3 In this case, VARs of order 1 means we are dealing with 1-day lag between online to onsite events (and vice-versa).

4 We also performed a multivariate time-series analysis with a VAR(1) model on the entire set of variables as a regression model of values at time t and variables observed at time $t-1$, with explanatory variables indicating possible and instantaneous correlation. However, and contrary to the pairwise approach, coefficients in the autoregressive matrix cannot be interpreted as valid because it is not possible to isolate individual effects or interpret a coefficient as the impact of an impulse shock on one variable at time *t-1* (with the remaining variables remaining unchanged). In this case, the causality can actually occur through another channel—i.e. a shock on *X2* at time $t-1$ might indicate a shock on *X3* at time $t-1$ or t can point to a shock on *X1*, so the causality interpretation might appear as valid with results that are likely to be misleading.

5 We selected a $p < .05$ as level of significance for the tests, so even in cases where H0 holds true, the causality can still be rejected with $\frac{1}{20}$ chance with a 5% criteria. We accepted the hypothesis of Granger causality and drew the conclusion that the first-order difference of variable Y Granger-causes the first-order difference of variable X whenever $p < .05$. When only one relationship was significant, we reported unidirectional Granger causality. When the relationship was significant both ways, we reported bidirectional Granger causality (feedback). If neither of them was significant, we rejected the hypothesis of Granger causality and concluded that the variables are independent.

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Appendix

Table A1 List of Twitter Hashtags Tracked During the Indignados, Occupy, and Vinegar Protests

	Indignados	Tweets	Start Date	Occupy	Tweets	Start Date	Vinegar	Tweets	Start Date
1	acampadaalbacete	825	19 May 2011	occupyamsterdam	31,754	9 October 2011	acordabrasil	68,581	18 June 2013
2	acampadaalicante	6,716	19 May 2011	occupyatlanta	47,369	18 October 2011	brazilianspring	358	18 June 2013
3	acampadabarcelona	3,822	19 May 2011	occupyaustin	43,473	9 October 2011	catraca_livre	1,512	13 June 2013
4	acampadabcn	387,057	19 May 2011	occupybaystreet	5,152	9 October 2011	catracalivre	1,515	13 June 2013
5	acampadabilbao	12,955	19 May 2011	occupyberlin	24,105	9 October 2011	changebrazil	285,385	16 June 2013
6	acampadaburgos	394	19 May 2011	occupyboston	213,004	9 October 2011	chupadilma	28,200	16 June 2013
7	acampadacadiz	5,504	19 May 2011	occupychicago	75,204	9 October 2011	contraoaumento	7,167	13 June 2013
8	acampadacartagena	1,569	19 May 2011	occupydc	195,909	9 October 2011	mudabrasil	103,614	18 June 2013
9	acampadacoruña	11,609	19 May 2011	occupydenver	147,155	9 October 2011	obrasilacordou	12,411	18 June 2013
10	acampadagirona	5,722	19 May 2011	occupydublin	1,680	16 October 2011	ogiganteacordou	181,511	18 June 2013
11	acampadagranada	22,228	19 May 2011	occupyfrankfurt	11,723	16 October 2011	passe_livre	41,810	13 June 2013
12	acampadahuelva	5,030	19 May 2011	occupyhouston	25,510	9 October 2011	passelivre	37,942	13 June 2013
13	acampadaleon	6,452	19 May 2011	occupyhollywood	1,975	2 November 2011	primaverabrasileira	4,460	18 June 2013
14	acampadalugo	1,877	19 May 2011	occupyjackson	947	9 October 2011	protesto	2,210,304	13 June 2013
15	acampadamadrid	1,388	19 May 2011	occupyla	193,093	9 October 2011	protestobh	41,651	17 June 2013
16	acampadamalaga	19,644	19 May 2011	occupylasvegas	14,290	9 October 2011	protestobr	30,683	17 June 2013
17	acampadamallorca	193	19 May 2011	occupylondon	82,370	9 October 2011	protestoce	10,698	17 June 2013
18	acampadamurcia	20,759	19 May 2011	occupylouisville	9,873	9 October 2011	protestoemvitoria	1,899	18 June 2013
19	acampadapamplona	5,795	19 May 2011	occupylsx	227,992	11 October 2011	protestopelotas	1,572	17 June 2013

Table A1 Continued

	Indignados	Tweets	Start Date	Occupy	Tweets	Start Date	Vinegar	Tweets	Start Date
20	acampadasalamanca	9,579	19 May 2011	occupymadison	10,129	9 October 2011	protestopoa	18,044	17 June 2013
21	acampadasantander	5,026	19 May 2011	occupymcr	1,715	17 October 2011	protestorj	114,557	16 June 2013
22	acampadasantiago	439	19 May 2011	occupymelbourne	76,539	9 October 2011	protestosp	133,260	13 June 2013
23	acampadasevilla	23,816	19 May 2011	occupymemphis	4,005	9 October 2011	revogaoaumento	2,243	17 June 2013
24	acampadasol	331,324	19 May 2011	occupyoakland	309,185	2 November 2011	saladuprising	839	18 June 2,013
25	acampadatenerife	15,083	19 May 2011	occupyparis	3,427	9 October 2011	sp13j	6,366	13 June 2013
26	acampadatoledo	2,904	19 May 2011	occupypdx	36,444	17 November 2011	sp17j	953	18 June 2013
27	acampadavalencia	35,811	19 May 2011	occupysandiego	11,941	9 October 2011	tarifa	455,756	13 June 2013
28	acampadavalladolid	7,724	19 May 2011	occupyseattle	100,960	9 October 2011	tarifa_zero	3,767	13 June 2013
29	acampadavigo	8,591	19 May 2011	occupysf	186,233	17 October 2011	tarifazero	2,166	13 June 2013
30	acampadazamora	4,229	19 May 2011	occupysydney	50,290	9 October 2011	todarevolu-caocomeca	2,219	16 June 2013
31	acampadazaragoza	1,247	19 May 2011	occupytampa	9,088	9 October 2011	todosjunto-sporumbr	3,578	16 June 2013
32	antesdelfindelmundo	88,884	19 May 2011	occupytokyo	7,528	9 October 2011	vdevinagre	1,776	18 June 2013
33	notenemosmiedo	44,495	19 May 2011	occupytoronto	89,409	9 October 2011	vemprarua	534,936	16 June 2013
34	m15	13,552	19 May 2011	occupywallst	546,020	9 October 2011	verasqueum-filhoteu	603,876	16 June 2013
35	spanishrevolution	756,075	17 May 2011	occupywashington	1,628	9 October 2011	vforvinegar	179	18 June 2013
	Total indignados tweets:	1,868,318		Total occupy tweets:	2,797,119		Total vinegar tweets:	4,955,788	

Table A2 List of Facebook Groups and Pages Tracked During the Indignados, Occupy, and Vinegar Protests

	Indignados	Posts	Start Date	Occupy	Posts	Start Date	Vinegar	Posts	Start Date
1	acampadabcn	2,268	16 May 2011	occupyamsterdam	3125	15 October 2011	atopelotas	827	14 June 2013
2	acampadabcn	8,212	16 May 2011	occupyatlanta	8,893	23 September 2011	braziliansprin g	1,435	16 June 2013
3	acampadaalicante	423	19 May 2011	occupyaustin	2,133	15 October 2011	catracalivre	400	16 June 2013
4	acampadabilbao	3,121	19 May 2011	occupyberlin	2,580	2 October 2011	contracorrupcao	1,425	16 June 2013
5	acampadacartagena	420	23 May 2011	occupyboston	21,537	2 October 2011	contraoaumentobelem	47	14 June 2013
6	acampadagirona	1,525	26 May 2011	occupychicago	20,817	2 October 2011	contraoaumentoes	75	14 September 2011
7	acampadagranada	4,875	17 May 2011	occupydallas	9,843	2 October 2011	forumcontraoaumento	575	17 October 12
8	acampadacoruna	1,227	17 May 2011	occupyfrankfurt	5,100	25 September 2011	manifestopoa	1,000	6 June 2013
9	acampadaleon	47	22 May 2011	occupyhouston	8,632	23 September 2011	movimentocontracorru	50	14 February 2013
10	acampadaensol	11,475	16 May 2011	occupyla	24,293	21 September 2011	mplguarulhos	219	17 June 2013
11	acampadamalaga	799	23 May 2011	occupylasvegas	3,358	25 September 2011	mplgv	150	2 June 2013
12	acampadamurcia	450	21 May 2011	occupylondon	17,430	25 September 2011	mplipatinga	19	26 June 2013
13	acampadasalamanca	2,807	17 May 2011	occupymadison	4,871	24 September 2011	mplitaperuna	101	17 June 2013
14	acampadasantander	500	18 May 2011	occupymanchester	140	1 October 2011	mpljoinville	275	29 May 2013
15	acampadasevilla	4,471	19 May 2011	occupymelbourne	6,008	26 September 2011	mplmanaus	68	18 June 2013
16	acampadatenerife	1,315	23 May 2011	occupynashville	6,293	24 September 2011	mplsalvador	240	10 June 2013
17	acampadavalencia	8,426	19 May 2011	occupyoakland	8,300	7 October 2011	mplssa	58	27 June 2013
18	acampadavalladolid	547	1 June 2011	occupyparis	94	2 October 2011	mudabrasil	1,775	5 June 2013
19	acampadazamora	413	19 May 2011	occupyphiladelphia	16,051	23 September 2011	niteroicontraoaumento	399	12 June 2013
20	acampadazaragoza	74	27 May 2011	occupysandiego	1,183	9 November 2011	obrasilacordou	13,497	16 June 2013

Table A2 Continued

	Indignados	Posts	Start Date	Occupy	Posts	Start Date	Vinegar	Posts	Start Date
21	acampadabcn	40	20 October 12	occupysanfrancisco	4,115	23 September 2011	ogiganteacordou	4,720	15 June 2013
22	spainonymous	40	20 October 12	occupyseattle	16,487	23 September 2011	passelivrebh	78	14 June 2013
23	NA	NA	NA	occupysydney	2,957	27 September 2011	passelivrefloripa	1,375	2 April 2013
24	NA	NA	NA	occupytampa	7,744	23 September 2011	passelivrego	35	15 June 2013
25	NA	NA	NA	occupytokyo	1,465	29 September 2011	passelivremaringa	74	18 June 2013
26	NA	NA	NA	occupytoronto	13,940	22 September 2011	passeLivrepe	45	18 June 2013
27	NA	NA	NA	occupyvancouver	911	20 October 2011	passelivrerj	2,910	24 May 2013
28	NA	NA	NA	occupywallstreet	97,297	18 September 2011	passelivrerp	250	23 April 2013
29	NA	NA	NA	occupywashington	1,729	3 October 2011	passelivresjc	198	24 May 2013
30	NA	NA	NA	NA	NA	NA	passelivresp	1,100	15 June 2011
31	NA	NA	NA	NA	NA	NA	pulacatracapiracicaba	275	30 April 2013
32	NA	NA	NA	NA	NA	NA	tarifazerogoiania	150	8 June 2013
33	NA	NA	NA	NA	NA	NA	tarifazeroorg	100	25 Mar 2013
34	NA	NA	NA	NA	NA	NA	vdevinagre	928	14 June 2013
35	NA	NA	NA	NA	NA	NA	vemprarua	1,224	18 June 2013
	Total indignados posts:	53,475		Total occupy posts:	317,326		Total vinegar posts:	36,215	

Table A3 Daily-Aggregated Data of Indignados With Number of Tweets, Facebook Posts, Protestors, Camped-Out, and Arrests

Date	Twitter	Facebook	Protestors	Camped	Arrests
17 May 2011	64,534	1,877	12,600	890	26
18 May 2011	109,033	3,646	10,825	310	3
19 May 2011	174,193	4,195	25,410	1,230	NA
20 May 2011	160,900	8,559	88,880	4,775	NA
21 May 2011	9,917	7,264	28,170	450	NA
22 May 2011	13,024	8,287	2,800	NA	NA
23 May 2011	33,763	7,092	500	NA	NA
24 May 2011	24,458	6,893	3,450	NA	NA
25 May 2011	26,678	6,784	7,000	NA	NA
26 May 2011	22,052	5,342	1,500	450	NA
27 May 2011	198,095	12,647	22,000	400	NA
28 May 2011	49,360	6,710	25,400	NA	NA
29 May 2011	42,680	9,089	18,100	50	NA
30 May 2011	25,721	5,026	250	110	NA
31 May 2011	20,336	4,911	270	NA	NA
1 June 2011	15,545	3,469	1,000	NA	NA
2 June 2011	11,256	3,466	NA	NA	NA
3 June 2011	11,375	3,028	2,500	NA	NA
4 June 2011	10,865	2,087	NA	NA	NA
5 June 2011	14,275	3,245	1,700	NA	NA
6 June 2011	11,906	2,715	100	150	NA
7 June 2011	8,188	2,414	NA	NA	NA
8 June 2011	13,425	6,599	1,500	NA	NA
9 June 2011	15,304	8,811	2,000	NA	5
10 June 2011	9,049	4,408	2,000	NA	NA
11 June 2011	11,182	5,938	3,600	NA	5
12 June 2011	5,742	3,210	25	NA	NA
13 June 2011	4,743	2,242	NA	NA	NA
14 June 2011	5,561	2,749	1,500	NA	NA
15 June 2011	8,929	2,532	NA	NA	7
16 June 2011	6,734	3,541	500	NA	NA
17 June 2011	6,233	2,529	40	NA	NA
18 June 2011	4,979	2,379	NA	NA	NA
19 June 2011	9,561	6,699	212,000	NA	NA
20 June 2011	4,850	3,106	500	NA	NA
21 June 2011	3,736	1,880	NA	NA	NA
22 June 2011	2,783	1,369	200	NA	NA
23 June 2011	3,135	1,252	NA	NA	NA
24 June 2011	2,367	1,183	NA	NA	NA
25 June 2011	2,373	948	NA	NA	NA
26 June 2011	1,944	888	NA	NA	NA
27 June 2011	2,443	772	NA	NA	NA
28 June 2011	2,147	889	NA	NA	NA
29 June 2011	3,147	1,125	NA	NA	NA

Table A4 Daily-Aggregated Data of Occupy With Number of Tweets, Facebook Posts, Protestors, and Arrests

Date	Twitter	Facebook	Protestors	Arrests
24 September 2011	67,831	3,469	2,000	84
25 September 2011	86,020	6,053	NA	NA
26 September 2011	61,540	8,621	NA	NA
27 September 2011	58,503	7,748	1,500	NA
28 September 2011	48,819	8,135	NA	724
29 September 2011	51,381	10,548	50	NA
30 September 2011	72,795	14,233	10,000	NA
1 October 2011	119,949	10,851	11,500	700
2 October 2011	160,375	25,279	2,000	25
3 October 2011	111,720	12,219	2,300	NA
4 October 2011	93,656	11,038	360	NA
5 October 2011	126,430	38,270	7,500	4
6 October 2011	182,809	29,582	10,435	NA
7 October 2011	125,419	14,464	6,500	32
8 October 2011	113,749	11,212	4,343	151
9 October 2011	111,224	22,869	1,900	11
10 October 2011	104,937	29,016	5,300	12
11 October 2011	113,272	21,211	70	60
12 October 2011	94,850	21,634	56,200	93
13 October 2011	128,527	23,845	2,000	263
14 October 2011	209,466	31,384	5,000	2
15 October 2011	236,589	47,431	55,900	19
16 October 2011	216,594	33,896	4,010	NA
17 October 2011	154,140	23,779	300	12
18 October 2011	134,456	33,968	NA	12
19 October 2011	114,512	31,655	4,000	33
20 October 2011	99,720	20,449	8,000	NA
21 October 2011	113,811	26,581	NA	253
22 October 2011	107,671	27,024	520	134
23 October 2011	96,621	15,905	650	NA
24 October 2011	86,773	20,324	240	5
25 October 2011	1,00E + 05	21,105	124	473
26 October 2011	180,928	20,334	NA	73
27 October 2011	191,571	36,045	139	62
28 October 2011	114,409	29,795	NA	9
29 October 2011	110,132	14,013	300	9
30 October 2011	120,560	9,885	50,000	10
31 October 2011	88,256	13,647	1	188
1 November 2011	83,698	13,895	8	31

Table A4 Continued

Date	Twitter	Facebook	Protestors	Arrests
2 November 2011	114,322	18,747	6,000	87
3 November 2011	173,555	27,328	NA	34
4 November 2011	90,590	12,975	3,000	47
5 November 2011	101,395	17,207	105	23
6 November 2011	81,342	13,163	NA	84
7 November 2011	74,007	13,305	10,000	42
8 November 2011	66,892	11,042	NA	3
9 November 2011	67,713	15,300	25	100
10 November 2011	73,488	18,167	NA	79
11 November 2011	64,799	13,081	10	71
12 November 2011	39,723	10,955	80	239
13 November 2011	48,012	7,768	NA	154
14 November 2011	61,851	9,969	30,000	514
15 November 2011	414,408	12,207	NA	200
16 November 2011	149,538	23,051	NA	2
17 November 2011	317,896	14,049	30,000	54
18 November 2011	182,736	12,491	20	16
19 November 2011	130,792	12,964	10	1
20 November 2011	121,963	21,802	NA	10
21 November 2011	108,784	17,188	NA	35
22 November 2011	100,781	17,947	NA	24
23 November 2011	80,861	9,996	80	2
24 November 2011	50,441	8,117	NA	NA
25 November 2011	50,890	4,943	NA	6
26 November 2011	59,127	4,695	4,000	16
27 November 2011	52,745	10,575	1,092	381
28 November 2011	67,955	14,156	NA	11
29 November 2011	51,906	14,449	NA	3
30 November 2011	80,003	15,618	40	26
1 December 2011	59,494	12,702	NA	58
2 December 2011	58,100	17,310	30	26
3 December 2011	48,715	8,871	NA	12
4 December 2011	58,763	11,940	NA	167
5 December 2011	57,440	10,601	NA	35
6 December 2011	59,460	13,634	NA	13
7 December 2011	64,269	13,396	NA	48
8 December 2011	60,649	13,255	NA	55
9 December 2011	59,725	13,393	5200	70
10 December 2011	30,892	8,866	50	13
11 December 2011	11,768	28,935	NA	2

Table A4 Continued

Date	Twitter	Facebook	Protestors	Arrests
12 December 2011	20,512	14,613	NA	5
13 December 2011	16,972	10,986	NA	1
14 December 2011	7,346	8,548	NA	63
15 December 2011	9,201	9,293	NA	8
16 December 2011	7,280	10,936	NA	38
17 December 2011	5,996	10,703	NA	8
18 December 2011	5,420	7,246	NA	1
19 December 2011	5,362	6,787	NA	13
20 December 2011	10,547	8,399	NA	NA
21 December 2011	6,898	15,348	NA	NA
22 December 2011	6,154	7,183	NA	4
23 December 2011	5,021	5,962	NA	NA
24 December 2011	3,737	6,474	NA	NA
25 December 2011	2,271	16,752	NA	10
26 December 2011	2,416	7,938	NA	12
27 December 2011	3,439	4,924	NA	32
28 December 2011	3,373	5,505	NA	NA
29 December 2011	4,299	10,327	12	NA

Table A5 Daily-Aggregated Data of Vinegar With Number of Tweets, Facebook Posts, Protestors, Injuries, and Arrests

Date	Twitter	Facebook	Protestors	Injuries	Arrests
13 June 2013	17,728	99,002	17,200	100	325
14 June 2013	48,818	159,185	NA	NA	NA
15 June 2013	25,605	57,860	NA	NA	NA
16 June 2013	39,857	253,709	NA	NA	NA
17 June 2013	265,774	201,670	275000	4	5
18 June 2013	294,257	239,827	130,500	NA	63
19 June 2013	180,496	354,571	152,000	NA	3
20 June 2013	33,365	207,808	1,569,150	78	52
21 June 2013	33,728	321,230	330,450	NA	27
22 June 2013	20,696	330,247	52,500	NA	5
23 June 2013	14,594	77,910	4,000	NA	NA
24 June 2013	13,036	368,754	8,650	2	NA
25 June 2013	12,166	199,199	11,000	NA	35
26 June 2013	17,069	573,286	88,500	NA	1
27 June 2013	13,342	308,716	4,150	4	8
28 June 2013	10,626	339,611	9,500	NA	NA
29 June 2013	8,525	211,240	NA	NA	NA

Table A6 Aggregated Sources of Press Reports on the Number of Protestors, Injuries, and Arrests

Indignados		Occupy		Vinegar	
elpais.com	80	bbc.co.uk	8	g1.globo.com	107
publico.es	31	cbc.ca	8	folha.uol.com.br	12
europapress.es	29	guardian.co.uk	6	noticias.terra.com.br	10
elmundo.es	24	demotix.com	4	zerohora.clicrbs.com.br	8
rtve.es	14	kentucky.com	4	estadao.com.br	7
democraciarealya.es	10	latimeslatimes.com	4	infonet.com.br	5
20minutos.es	7	mlive.com	4	noticias.uol.com.br	5
abc.es	6	msnbc.msn.com	4	tribunadonorte.com.br	5
ideal.es	6	reuters.com	4	independente.com.br	3
elperiodico.com	5	unionleader.com	4	ne10.uol.com.br	3
larazon.es	5	24ur.com	3	oglobo.globo.com	3
ecodiario.eleconomista.es	4	index.hr	3	tribunademinas.com.br	3
bbc.co.uk	3	liverpoolecho.co.uk	3	acritica.uol.com.br	2
eldiariomontanes.es	3	mysanantonio.com	3	atarde.uol.com.br	2
libertaddigital.com	3	smh.com.au	3	brasil247.com	2
madrid.tomalaplaza.net	3	takethesquare.net	3	cartacapital.com.br	2
sup.es	3	tar.txstate.edu	3	cenariomt.com.br	2
washingtonpost.com	3	thenewstribune.com	3	cidadeverde.com	2
diagonalperiodico.net	2	torillatavataan.wordpress.com	3	clicrbs.com.br	2
diariodemallorca.es	2	vancouversun.com	3	cruzeirodosul.inf.br	2
diariosur.es	2	thelede.nytimes.com	2	d24am.com	2
elcomentario.tv	2	abcnews.go.com	2	dgabc.com.br	2
eldia.es	2	acramento.cbslocal.com	2	diariocatarinense.clicrbs.com.br	2
lanacion.com.ar	2	articles.wsbt.com	2	diariodovale.uol.com.br	2
lasprovincias.es	2	bangordailynews.com	2	diariosp.com.br	2
laverdad.es	2	bizjournals.com	2	em.com.br	2
lavozdegalicia.es	2	boiseweekly.com	2	epochtimes.com.br	2
lne.es	2	ca.news.yahoo.com	2	folhavitoria.com.br	2
que.es	2	cbs3springfield.com	2	jornaldesergipe.com	2
rollingstone.es	2	crainsnewyork.com	2	mogiguacuacontece.com.br	2
tomalaplaza.net	2	eattletimes.nwsource.com	2	nominuto.com	2
webcitation.org	2	edition.cnn.com	2	opovo.com.br	2
abcdesevilla.es	1	elmostrador.cl	2	quintaldanoticia.com.br	2
acampadadebarcelona.org	1	abclocal.go.com	2	rastro101.com.br	2
OTHERS	111	OTHERS	578	OTHERS	113
TOTAL	380	TOTAL	686	TOTAL	328