# Broadband Internet and Protests:
## Investigating the Occupy Movement in the United States

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**Abstract**

This paper investigates the influence of broadband Internet availability in the occurrence of events of civil unrest, using collected data on the locations of protesting activities related with 2011's Occupy Movement in the U.S. We consider the hypothesis that the Internet sets an environment for communication and information exchange that boosts collective dissatisfaction towards unfair policies. Linear estimates suggest that each new Internet Service Provider (which is associated to an increase in broadband penetration of about 0.5 p.p.) accounts for an increase between 1 and 3 p.p. in the probability of observing protests in a given location. Results are consistent when analyzing county-level data for the contiguous U.S., for each different U.S. region separately (Norheast, Midwest, South and West), and when analyzing city-level data for California.

**Keywords:** Internet; Civic Engagement; Protests; Occupy Movement.

**JEL Classification:** C26, D74, L86.

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"Even places traditionally more muted, such as Japan and Singapore, have seen demonstrators in the streets. Social inequalities and political discontent have spurred citizens to gather. Resistance can be co-ordinated with greater ease than ever in the age of the smartphone." The Economist, Dec 23rd, 2013. *Social unrest in 2014: Protesting predictions.*

# 1 Introduction

In this paper we use data on protesting activities related with the Occupy Movement in the United States to investigate whether the availability of broadband Internet stimulates political mobilization in the form of public demonstrations.

Throughout history, events of civil unrest have played an important role in shaping the social and political structures of societies, ranging from small and peaceful demonstrations to confrontations that ultimately led to grievous outcomes. In this context, the act of protesting as a channel of political participation is one that has been receiving growing attention from media and academic literature in recent years. Not without reason, this past decade has been a stage for various acts of protest around the world, as well as for a perceptible rise in the number of such events each and every year.[1]

In the same way, this last decade (and the one before) was also witness to a huge change in another important aspect of social interactions: the communication revolution. The introduction of dial-up Internet, its upgrade to broadband and Wi-Fi connections, the inception of mobile and smartphones, the increasing accessibility to personal computers and the popularization of social networks, have all drastically changed the way human beings produce, acquire and share information with one another. Not only that, such innovations may have set the path on how our society will evolve from now on, which is not at all a strong statement if we consider how Information and Communication Technologies (ICT, hereafter) have contributed, for instance, to the global exportation of western culture (Benyon & Dunkerley, 2014) and to new breaths towards democratization in countries from the Arab world (Hussain & Howard, 2012). In terms of figures, it is estimated that Internet usage and mobile phone subscriptions have increased worldwide at a rate between 2.78% and 7.4% per year, respectively, in the course of this last decade.[2]

The combination of these two facts led many researchers in social and technological sciences wonder about how the Internet and social media may have influenced the course of recent popular movements. Many argue that the advent of the Internet was the key factor that allowed these movements to emerge in such a spontaneous fashion. However, actual evidence on the relation between the Internet and protests is scarcely available beyond anecdotal facts, hindering any causal claim between the two. The main objective of this study, therefore, is

[1] This increasing trend is documented in Ortiz et al. (2013), during the time period between 2006 and 2013.
[2] Data from 2005 to 2013; Source: World Bank.

to provide empirical evidence of how the development of ICTs have positively influenced the incidence of events of civil unrest, by studying the impact that broadband Internet availability had on the spread of the so-called Occupy Movement in the United States.

Inspired by other recent events of social unrest, such as the Arab Spring and the Spanish “Indignados”, and sparked by an embryonic event known as Occupy Wall Street (the first “Occupy” demonstration that happened on September 2011 in Zuccotti Park, New York City), the Occupy Movement refers to the series of protests that spread throughout the U.S. territory in late 2011, eventually becoming one of the most relevant episodes of mass protesting in recent years. Its core purpose was to raise awareness about the control that financial systems and big corporations exert in society in a way to disproportionately benefit a minority share of the population, and how this would undermine the proper functioning of a democratic society. Evidence of demonstrations held as part of the movement can be traced to hundreds of U.S. cities, and the movement also had international presence with demonstrations being held in many places outside the U.S. Its main motto, “we are the 99%” - a reference to the income and wealth distribution inequality between the wealthiest 1% and the rest of the population - was widely disseminated by the worldwide media.

The choice of the Occupy movement as a case study for this analysis is justified by a number of particular features to this event that should ease the isolation of the raw relationship between broadband availability and protesting. First, there is the fact that the U.S. is the oldest and arguably the most solid democratic community in our world today. The First Amendment to the United States Constitution specifically allows its citizens to engage in peaceful demonstrations and guarantees their freedom of assembly as part of a measure to facilitate the redress of their grievances. In fact, many of the actions taken by protesters during the movement were in the form of peaceful sign-holding marches, rallies and pickets. Real acts of trespassing were more notably observed in the bigger cities, where protesters “occupied” public squares by organizing sit-ins and/or camping communities, and only in a few of these places - considering that such demonstrations were observed in more than 600 cities - protesters encountered severe repression from the police in the early phase of their installments. Such an environment could have signaled a low opportunity cost to engage in protests, enough to diminish the psychological threshold preventing individuals who felt aggrieved from going to the streets.

Second, despite the striking proportions achieved by the movement, outdoor demonstrations did not last long: the bulk of collected data of Occupy-related protests is mainly concentrated in the months of October and November 2011, with very few episodes registered outside this time frame. On one hand, this fact turns out to be of great convenience to our analysis since, by having observations restrained to a window of only two months, possible strong sources of bias such as changes in climate, in macroeconomic conditions and in other possible unobservable variables are unlikely to be of great impact to our estimates. However, by dealing with data of cross-sectional nature, our possibilities for investigating long-term trends between our variables of interest and for designing robustness checks such as placebo regressions using periods before broadband deployment are somehow restricted, which is a problem we try to overcome using alternative data for political participation in the U.S. (i.e. presidential elections turnout).

A third feature concerns the observed motives of the Occupy protests. Despite the declared general request to end financial corporations' influence on politics, as disseminated by most of the mainstream media that covered the protests, there was not, indeed, a unifying demand among its participants that could characterize the movement as a whole. Castells (2015) gives further evidence in favor of this statement: "The movement demanded everything and nothing at the same time. In fact, given the widespread character of the movement, each occupation had its local and regional specificity: everybody brought in her own grievances and defined her own targets." The author later points that the list of most frequently mentioned demands debated in various of the Occupy-related events and campsites was of extraordinary diversity, ranging from positions against economic austerity, government corruption and other financial and political subjects to concerns about health care, student loans, global warming, sexism, and animal rights. This supports the idea that mass movements of social unrest, in their most contemporary forms, could be a phenomena arising from the increased possibility of information acquisition and collective action through the Internet network, which would possibly be playing a significant causal role by bringing together unsatisfied citizens from a much diverse pool of complaints.

To identify the sought causal relationship between broadband Internet and the Occupy protests, we use an instrumental variable approach in our main empirical specification, using topographic elevation as an exogenous determinant to the provision of broadband Internet. The use of physical geographic elements, such as weather and topography, as a means for identification frameworks is common in many empirical studies because of the generally random and predetermined nature they possess, as we see for example in Miguel et al. (2004), Hussain & Howard (2010) and Yanagizawa-Drott (2014). In addition, Jaber (2013) has introduced the use of terrain elevation specifically as an instrument to broadband Internet in the U.S., since it captures some of the costs of building and maintaining cable infrastructure - which, by 2011, was the most used technology for signal distribution in the U.S. We argue, based on evidence from his research, that low-lying areas are more prone to floods and exhibit higher summer temperatures, and that such climate conditions have played a role in today's deployment of broadband infrastructure. To give basis to the exclusion restriction hypothesis, we test some variations in our main specification using several sets of covariates.

We perform analogous exercises for each of the different U.S. regions separately (Norheast, Midwest, South and West), and for California using data disaggregated at the city-level. We also explore alternative identification methods, such as a recent estimator developed by Lewbel (2012) that exploits heteroskedasticity for identification and does not rely on exclusion restrictions. In all cases, estimates obtained were very similar to one another, thus providing us robust evidence that the studied effect of broadband Internet on the occurrence of protests is, in fact, positive and significant.

To shed some light on the mechanisms behind the studied effect, we ground our main linear specification on the model of determinants to political unrest developed by Passarelli & Tabellini (forthcoming), also incorporating a role to broadband availability. The model is motivated by the following argument: By having fair accessibility to broadband services through technologies such as ADSL (Asymmetric Digital Subscriber Line), cable and Wi-Fi, people are able to fully utilize several devices that are today the principal means of digital intercommunication, such as computers, tablets and smartphones. Those technologies have become better alternatives in terms of cost and communication dynamics for short and long distance data exchange between two - or a group of - people, in comparison to, for example, direct phone calls or Short Message Services (SMS). Besides its wide use for entertainment and personal matters, the possibility of such broad intercommunication, powered up by different platforms within the Internet service such as forums, communities, blogs, social networks and on-line News, allows for an accessible and unprecedented networked environment for information sharing, factual transparency and free expression.

We define a protest as a political resource for an individual (or a group of individuals) to publicly express a discontent provoked by situations, policies or events for which an entity that holds some form of power in society - be it economic, political, military, ideological or cultural - is assumed to bear responsibility. The engagement in a protest is for every agent a decision based in the threshold between costs and benefits he perceives from the act of protesting. This relation is strongly based in variables such as: how the individual is affected by this discontent, how large is the group set to protest together with him and what kind of repression might he face in doing so. In this context, the use of such a network for communication, made possible by broadband infrastructure, would improve an agent's perception on how these entities have a part on their aggrievement and also serves as a tool for collective coordination.

There are a few other contemporaneous studies that investigate the causal effect of broadband Internet on outcomes such as corruption (Andersen et al., 2011), labor market outcomes (Atasoy, 2013) and voting behavior both in the U.S. (Larcinese & Miner, 2012; Jaber, 2013) and in other countries (Czernich, 2012; Miner, 2015; Falck et al., 2014; Campante et al., 2013). There is also a growing body of empirical (Machado et al., 2011; Esteban et al., 2012; Voth, 2012; Yanagizawa-Drott, 2014; Aguilar & Ferraz, 2014) and theoretical (Shadmehr & Bernhardt, 2011; Shadmehr, 2014; Little, 2016; Passarelli & Tabellini, ming, forthcoming) research on the determinants of events of social unrest. In this paper, we contribute to both literatures by focusing on protests as a political outcome for broadband penetration. Likewise, many other studies have been conducted on the political economy of traditional media, such as in the effects of newspapers on government responsiveness (Besley & Burgess, 2002); newspapers on reducing corruption (Reinikka & Svensson, 2005); newspapers on federal spending in a district (Snyder Jr & Strömberg, 2010); newspapers on electoral politics (Gentzkow et al., 2011); newspapers on civic attitudes and economic development (Cagé & Rueda, 2014); television on voter turnout (Gentzkow, 2006); television on presidential elections (DellaVigna & Kaplan, 2007); radio on political violence (Yanagizawa-Drott, 2014); and mobile phones on political mobilization (Manacorda & Tesei, 2016).

After this introduction, the remainder of this paper is organized as follows. Section 2 characterizes the Occupy Movement in the U.S. with more detail. Section 3 develops our empirical framework. Section 4 presents the data. Section 5 presents the results. Section 6 develops alternative specifications and robustness tests. Section 7 presents our concluding remarks.

# 2 The Occupy Movement

2011 was an eventful year to international politics. Early in January, the deteriorating social and political conditions in Tunisia brought massive discontent to its population and incited a civil uprising that completely changed the country's political landscape. Soon after, it propelled a wave of revolutionary movements in many Arab countries towards the rule of local governments and dictatorial regimes, culminating in what is now referred to as the Arab Spring. Most noticeable among them, in Egypt more than 2 million people protested for two weeks straight in Thair Square (Cairo's major public square) and manage to get long-time president/dictator Hosni Mubarack to step down, despite the continuous violent advances from the national security forces. These events were rapidly disseminated to the rest of the globe through the media and the Internet, inspiring many anti-austerity social movements that followed, for example, in Spain, Ukraine, the U.K., Russia, China, Israel and many countries in Africa and Latin America.[3] The U.S., not differently, had its own outbreak of civil disobedience in late 2011, with the onset of the Occupy Movement - the biggest social movement in the country in recent decades.

The Occupy Movement did not emerge out of pure fashion. In 2011, the U.S. economy was still dealing with the break of its real state market and collapse of its financial system two years before, which put thousand of families out of their homes, left millions unemployed and widened the country's inequality gap even further. The resulting general aggrievement, together with all the news of protests happening worldwide that same year, changed the public attitude towards the political system and instigated people to take action. It happened first in New York City: on september 17, 2011, hundreds of people gathered in Zuccotti Park (which is two block away from Wall Street) and literally occupied that public space, setting up tents and organizing a sort of independent community that lasted for several days. This first event was held under the title of Occupy Wall Street (OWS), and its core demand was the appointment of a presidential commission to disentangle the financial system (represented by Wall Street) from any decision made in the White House.

The events in New York City quickly gained the attention of the national media, and several

[3]In a playful and accurate retrospect, Time Magazine awarded to "the protester" the title of Person of The Year in 2011

related news, images and videos started flooding the Internet calling the whole country to join OWS's cause. In the first half of October 2011, the movement spread to many of the main urban centers such as Jersey City, Philadelphia, Hartford, Boston, Washington DC, Cleveland, Cincinnati, Chicago, Atlanta, Tampa, Fort Lauderdale, Austin, Houston, Las Vegas, Los Angeles, San Francisco, Salt Lake City, Oakland and Seattle. By the end of October/beginning of November, the movement have reached the whole nation: we estimate that support in the form of web activities came from as many as 800 cities, and that more than 600 have had physical events related to the Occupy protests. This quick and spontaneous spread of one single social movement to so many different places in the U.S. is unprecedented, and is the main phenomenon under investigation in this paper. It does suggests the depth in meaning behind this movement, rooted in the outrage that spoke to the majority of the population across the country, but it also raises the question of how meaningful was the role of the Internet in inducing these events.

The Internet is widely regarded as the main instrument that enabled the Occupy Movement to achieve such widespread support, as well as a substantial tool to its own internal dynamics. The movement began in the Internet and was diffused through the Internet, and just then it took material form with all the protests and occupation of public spaces. The different forms in which these demonstrations were held, in turn, reflected particular specificities of each place: they ranged from small rallies, or daily gathering and working groups, to huge camp settings that lasted for several days. Organization in such camps also varied by place, although there was an effort to maintain a general structure considered consistent with the movement's principles: there were no formal leaderships and the decisions that affected the whole group were made through general assemblies. These assemblies would normally follow a model of direct democracy, in which every one could have a say in the decision-making process.

The many ways the Internet and social media served as a tool the Occupy events is well described in Castells (2015). The early stages of the movement happened on-line trough the effort of a few activist blogs, which outlined the concept for the OWS months before the event took place in Zuccotti Park (the first call is generally atributed to the Canadian-based on-line magazine Adbusters). Testimonials that followed on independent and mainstream news websites and the many videos being posted on YouTube helped the movement speak to a broader audience and expand itself inland. From there, most of the created occupations started setting up their own websites and/or on-line groups in social networks, such as Facebook. Twitter became an essential tool for communication and action planning in and between the camps, and Livestream was also an important platform that helped publicize episodes of police repression. Even the movement's "99%" theme was popularized mainly because of a certain profile in the web page Tumblr. It is based on such characterization that we can describe the Occupy Movement as a hybrid event with presence in both cyber and urban spaces, networked in multiple forms of communication brought about by Internet - and broadband - technology.

Altogether, the Occupy Movement was largely a non-violent event, with very few registered episodes of harsher treatment and/or arrests engaged by local authorities and the police. These were generally targeted to occupations that resisted eviction orders, or when protesters became more confrontational (e.g. black blocs). In most cases, however, the authorities acted within the bounds of legality, although a few deviant cases can be pinpointed. For example, in Oakland, the Occupy camps were severely dismantled by the police, provoking riots that ended up costing millions to the city's administration. In the University of California at Davis (many occupations were held in university campuses), the campus police deliberately pepper-sprayed students peacefully assembled in one of the university's courts. In each of these cases, the occurrences were widely publicized in the Internet, bringing even more external support to the movement.

The movement was also notable for its aggregating character, with great diversity in political ideology and social background among the participants, as well a wide variation in each one's degree of involvement. In one side, this copes with the idea that the movement was representative to various sectors of the civil society.[4] However, that plurality, that embracing scope through which the movement gained popularity, may have translated in one of its most important drawbacks: the absence of precise and well-delineated demands. That is, despite the stated unifying goal of separating money from politics, the movement was, indeed, motivated by a wide collection of general and personal grievances, and this transmitted a very diffused picture on what the protesters were actually asking for. As Castells (2015) once again describes:

> "The list of most frequently mentioned demands debated in various occupations hints at the extraordinary diversity of the movement's targets: controlling financial speculation, particularly high frequency trading; auditioning the Federal Reserve; addressing the housing crisis; regulating overdraft fees; controlling currency manipulation; opposing the outsourcing of jobs; defending collective bargaining and union rights; reducing income inequality; reforming tax law; reforming political campaign finance; reversing the Supreme Court's decision allowing unlimited campaign contributions from corporations; banning bailouts of companies; controlling the military-industrial complex; improving the care of veterans; limiting terms for elected politicians; defending freedom on the Internet; assuring privacy on the Internet and the media; combating economic exploitation; reforming the prison system; reforming health care; combating racism, sexism and xenophobia; improving student loans; opposing the keystone pipeline and other environmentally predatory projects; enacting policies against global warming; fining and controlling BP and similar oil spinners; enforcing animal rights; supporting alternative energy sources; critiquing personal leadership and vertical authority [...]; and watching out for cooptation in the political system [...]."

This feature turned out to be a fundamental flaw to the movement, as it failed to propose tangible measures to the problems it addressed and therefore no major policy change was carried out in the aftermath of the Occupy events. But one cannot say that the protests were for nothing, as several minor campaigns were created or continued after the end of movement, even if they were much smaller in scope. For example, there were a few demonstrations against foreclosures and attempts to put pressure on major national banks by encouraging clients to

[4] In terms of demographics, evidence shows that most engaged participants were formed of young professionals and/or students in the 20-40 age group, with the majority earning median income levels and holding higher educational degrees. In our analysis we will explore which demographic characteristics are mostly associated with places that have held Occupy-related demonstrations.

move their accounts to local banks and non-profit credit unions. It is also safe to say that the Occupy Movement succeeded in raising awareness to many Americans with regards to concrete flaws in their political system, and showed how the Internet can serve a powerful tool for political education and engagement.[5]

# 3 Empirical Framework

In this section, we draw insights from a model of collective decision-making to motivate our main linear specification and clarify the proposed mechanisms behind the studied effect. Next, we present our empirical setting in greater detail.

## 3.1 Theoretical background

We now present a theoretical background to formalize the links we latter estimate. Our model is a simplified version of Passarelli & Tabellini (forthcoming). We focus on the decision to engage in protests, and adapt their model in order to understand how the availability of Internet affects this decision.

Our economy consists of $N$ groups indexed by $i$, of size $1 > \lambda_i > 0$ with $\Sigma_i^N \lambda_i = 1$. Individuals decide whether to participate in protests weighting the private costs and benefits of doing so. The benefits are emotional, and are interpreted as the psychological reward of joining other members of the group in a public display of dissatisfaction with the status quo. This individual benefit is denoted by $a_i$ and it is common to all members of the group. It is interpreted as the aggrievement generated by the staus quo.[6] Crucially important, there are externalities related to the decision to protest, which make the benefit of protesting increasing with the share of people also protesting within a group. The share of people from group $i$ participation in protest is denoted by $p_i$. Moreover, we allow for a difference in the group's actual size $\lambda_i$ and the individual perception of its own groups size. We denote this perception by $\phi_i$. So the perceived benefit of participating in a protest is $a_i p_i \phi_i$.

Protesting also involve costs, such as time, transportation, risks of injury or arrest. They are composed of two elements $\mu + \epsilon_{ij}$, where $\mu$ is common to all individuals while $\epsilon_{ij}$ is a random variable reflecting the idiosyncratic cost of individual $j$ in group $i$. $\epsilon_{ij}$ is independently drawn from the continuous distribution $F_i$, with support on both sides of 0 and density denoted by $f(\cdot)$.

[5] A survey from the Pew Research Center conducted in 2012 ("Civic Engagement in the Digital Age", available at http://www.pewinternet.org/files/old-media//Files/Reports/2013/PIP_CivicEngagementintheDigitalAge.pdf), less then one year after the Occupy protests, shows that there has been a major growth in political activity on social networking sites since 2008. Also, many social networks users responded that their activity on the sites has prompted them to learn more about social or political issues and to take action around those issues.

[6] As proposed by Passarelli & Tabellini (forthcoming), the fundamentals for this reward are based on the group's sense of aggrievement, that is the distance between the utility level regarded as just and the true utility obtained from the government's policies, in this setting understood as the staus quo.

The level of access to Internet is represented by $\gamma$. For simplicity, we will assume it is the same for all groups. There are two channels through which Internet can affect the decision to protest. The first one is the *information effect*, which operates through the aggrievement, $a_i$. The logic is that with more information it is easier for individuals to hold decision makers accountable for their dissatisfaction with the status quo. Since Internet makes information easier to find, the proposed relationship is positive.[7] Then $a_i(\gamma)$ is an increasing (and differentiable) function. The second channel is the *coordination effect*. It operates through the perceived group size $\phi$. The idea is that an isolated individual may underestimate the actual size of his group, since it is more difficult to meet people with same preferences and ideals about the world. Internet access facilitates connections between individuals, though access to social networks, etc. As Internet access increases, groups become better connected and may have a better dimension of their true size. Thus, the perceived group size, $\phi_i(\gamma)$, is also increasing (and differentiable) with respect to the level of Internet access.

For simplicity we assume that by not protesting individuals receive an utility of zero. Then, individual $j$ in group $i$ will protest when

$$p_i a_i(\gamma)\phi_i(\gamma) - \mu - \epsilon_{ij} \geq 0.$$

In this setting, the share of individuals in group $i$ that will engage in protests is given by

$$p_i = F\left(p_i a_i(\gamma)\phi_i(\gamma) - \mu\right).$$

Notice that share of people participating in protest is in both sides of the equation. This means that the equilibrium share of protests, $p_i^*$ is a fixed point of the above equation. Applying the implicit function theorem we get

$$\frac{\partial p_i^*}{\partial \gamma} = \frac{f(p_i a_i(\gamma)\phi_i(\gamma) - \mu)p_i[a_i'(\gamma)\phi_i(\gamma) + a_i(\gamma)\phi_i']}{1 - f(p_i a_i(\gamma)\phi_i(\gamma) - \mu)a_i(\gamma)\phi_i(\gamma)} > 0. \tag{1}$$

We now discuss our empirical strategy, bearing in mind that we are proposing to identify a local estimate of (1). To simplify the notation, we denote $p_i^* \equiv Protest_i$ and $\gamma_i \equiv Internet_i$ and linearize the relationship depicted in (1). Therefore, we are proposing to identify a value for $\beta$ in

$$Protest_i = \beta Internet_i + \varepsilon_i, \tag{2}$$

and we expect our estimates for this value to be positive ($\beta > 0$).

[7] The idea is that with low information, an individual would not be sure if the current situation is a result of a bad state of nature or a unfavorable policy. Not being able then to hold the authorities responsible for his dissatisfaction.

### 3.2 Identification Strategy

To identify the effect of broadband Internet on the incidence of protests in the U.S., we rely on the fact that broadband availability varies across different places and that the wave of Occupy-related activities in 2011 was expressive in some places but absent in others. Our identification strategy is then based on two main specifications. First, we estimate OLS regressions of broadband availability on protests, controlling for a vector of covariates that are likely to predict trends on both broadband deployment and protesting incidence. That is, we estimate

$$Protest_i = \beta Internet_i + \boldsymbol{X}_i' \boldsymbol{\gamma} + \delta_s + \varepsilon_i \tag{3}$$

where $Internet_i$ is our measure of Internet availability in county $i$; $Protest_{is}$ is a binary variable denoting evidence of protest activity in county $i$; the vector $\boldsymbol{X}_i$ is the set of control variables and $\delta_s$ are state fixed effects.[8]

To account for differences in demographics, we use controls for population density, urbanization, median age, wealth and income, education, ethnicity and inequality. To capture differences in mobility and transportation infrastructure, we also add controls for the density of road and highways. To account for regional differences in political engagement and ideology, we control for election turnout, for the share of votes to the Democratic Party and for political competition, using data from the 2008 presidential elections in the U.S. Finally, we add a set of state dummies to control for state-specific idiosyncrasy common to each county.

Identification validity in this first specification depends on the (somewhat strong) assumption of conditional independence, in which estimates are causal when conditioned to observed characteristics in $\boldsymbol{X}_i$. Formally, take $Protest_{0i}$ and $Protest_{1i}$ as the theoretical outcomes on county $i$ with and without treatment, respectivelly. Then we have

$$\{Protest_{0i}, Protest_{1i}\} \perp\!\!\!\perp Internet_i | \boldsymbol{X}_i \tag{4}$$

However, even if we consider the right regressors in the vector of covariates, it is impossible to be fully comprehensive about all the possible variables that would map away endogeneity from our estimates, and that lead us to omitted variables bias. Measurement error is also a concern in our model, as we will show when describing our data in the next section. Therefore, in order to tackle such possible issues, we adopt an instrumental variable setting for our second main specification, using average elevation of the local terrain as an instrument for broadband

[8]Non-linear models may seem like the best alternative due to the binary nature of the dependent variable (zero or one). We follow, however, Angrist & Pischke's (2009) advice that linear probability models usually delivers similar results as non-linear regression models while allowing for an easier implementation and interpretation of causal effects. Using a *logit*/*probit* model also requires an assumption on the distribution of error terms, which introduces an additional bias in case the assumed distribution is incorrect. Nevertheless, results of marginal effects from a Probit model are also shown for comparison.

availability. First-stage regressions are then represented by the following equation:

$$Internet_i = \alpha \log(Elevation_i) + \boldsymbol{X}_i'\boldsymbol{\gamma} + \delta_s + \epsilon_i \tag{5}$$

where $\log(Elevation_i)$ is the instrumental variable for $Internet_i$, denoting the log-linearized average of land elevation in county $i$. To be a good instrument, $\log(Elevation_i)$ should be correlated with our main regressor, $Internet_i$, and impact $Protest_i$ only through its effect on the included regressors in the second stage (ideally through $Internet_i$ alone). Let us explore the possible mechanisms at play.

Demand and supply for broadband Internet service over the U.S. territory has been in course since the early 2000s, with cable access dominating the market as the lead technology. According to a report by IHS,[9] broadband market share for cable fixed connections exceeded 50 p.p. (percentage points) in 2013, leading over DSL which had 34 p.p. in that same year. Both technologies, in fact, are largely relied on cable-based infrastructure for signal transmitting (Frenzel, 2013). Other employed but less diffused technologies included fiber-optic cable, satellite, and wireless system.

As broadband infrastructure in the US is cable-based in its majority, we argue that climate differences cause higher elevation areas to be less costly for broadband infrastructure deployment when compared to low elevation areas, characterizing a source for exogenous variation. High-lying areas are for example less prone to floods, dispensing the necessity of raising barriers to protect broadband facilities, and exhibit lower summer temperatures, which reflects in lower costs of cable maintenance and less need of heat-resistant cable material.[10]

The exclusion restriction holds if terrain elevation has no correlation with ommited variables in the second stage, which would lead to correlation with its error term. One plausible concern is that, as we expect the influence of land elevation on broadband availability to be established mainly through its effect over climate, climate itself may have a direct influence on the incidence of protests, with places of milder temperatures and less precipitation, for example, being more

[9]Source: http://technology.ihs.com/468148/broadband-internet-penetration-deepens-in-us-cable-is-king.

[10]This argument was originally developed in Jaber (2013). In his unpublished paper entitled "Broadband Internet and Political Behavior: Evidence from the United States", the author draws evidence from a series of urbanistic studies to argue that the link between broadband and elevation should be positive, plausibly due to climate effects. He points out that there is "a strong negative relationship between land elevation and summer temperatures (Willmott & Matsuura, 1995)" and that "low-lying areas are subject to greater flooding of telecommunications infrastructure through storm surges and hurricanes (e.g. Michel-Kerjan & Kousky, 2010; Landry & Jahan-Parvar, 2011)". Thus, when built over terrains that are closer to sea level, cable infrastructure is more subject to damages from flooding, high ground temperatures, and excessive precipitation (Zimmerman & Faris, 2010), and such challenges "require the use of damage-resistant material and the construction of natural or artificial barriers (Rosenzweig et al., 2011)". He also points that "the reliance on land elevation to capture a multitude of influences at once is not unconventional, since geologists have already shown that land elevation predicts soil characteristics such as water content, crop yields, and vegetation type (Moore et al., 1991; Erskine et al., 2007)". Another challenge associated with building cable infra-structure in a flood-prone area is the difficulty of laying underground cable connections, which, in turn, "may affect the cost of building broadband infrastructure, as overhead poles are in general more susceptible to weather damage (Bascom III & Antoniello, 2011)".

prone to receive outdoor demonstrations such as sit-ins and rallies.

It is important, however, that we clarify an important distinction in our argument: the effect of climate on broadband infrastructure is defined by variables observed throughout the whole period that comprises deployment and maintenance of broadband infrastructure, whereas the direct effect of climate on protesting incidence should be driven by variables affecting only the smaller period of the Occupy protests, since it is intuitively plausible that climate records from the past should not influence the willingness of citizens to protest in the present. In any case, to handle this potential source of bias, we also include meteorological controls such as average temperatures and precipitation during the months of the Occupy events to test the consistency of our main results.

A second plausible concern is that the same geographical features that influence broadband deployment could also affect the provision of mobile phone coverage in the same direction, even if not through the same mechanisms. Areas with higher elevation are possibly more prone to better coverage the same way as broadband Internet should be more available in these areas, since, for example, reception towers are generally placed on high elevation or because reception can be better in general due to fewer obstructing objects.

As a starting point, we should address to our discussion in section 1 that mobile phones are today one of the many devices through which people have access to the Internet, greatly decreasing costs for communication relative to other means such as direct calls or SMS services. It is unlikely that variation in protesting activities would be too much due to the latter services since, according to the World Bank, 94 out of 100 Americans had mobile phone subscriptions in 2011. Evidence from the Pew Research Center[11] suggest, however, that as much as a third of Americas owned smartphones in 2011, so 3G technology - whose provision is not entirely congruent to the deployment broadband technology - could be a cofounder to our estimates. We therefore also include controls for 3G coverage to check that possibility.

# 4 Data

To assess the availability of broadband Internet over the U.S. territory, we rely on data from the Federal Communications Commission (FCC). On a semi-annual basis since late 1999, all Internet Service Providers (ISPs, hereafter) are required to report to the FCC all zip codes in which they have at least one high-speed Internet customer. A high-speed line, or broadband, was defined as one that provides a connection speed exceeding 200 kilobits per second (Kbps) in at least one direction, and includes technologies like Cable Modem, DSL, and wireless. Such information has since been subsequently summarized in state, county and zip code-level measurements and made publicly available in the FCC's website. We specifically utilize the data spreadsheet from the FCC Form 477 of December 31st, 2011, since it is the one which was

[11] "35% of American adults own a smartphone", available at http://www.pewinternet.org/files/old-media//Files/Reports/2011/PIP_Smartphones.pdf

assembled most closely to the time of the Occupy protests.[12]

Our main measure of broadband availability, $Internet_i$, is the number of ISPs operating in a county $i$.[13] One limitation, however, is that the FCC parameterize this count denoting a unity, "1", to the range of 1 to 3 ISPs. As an approximation, we rescale this number to "2" - the middle of the range between 1 and 3, introducing some degree of measurement error as consequence. To be a good measure of broadband availability, this variable must exhibit a clear link with the share of broadband subscribers in a given county, that is, it must have indeed an effect over the extent of broadband territorial penetration. Although theory on competitive markets and empirical evidence on broadband markets suggest the existence of such a link (e.g. Bresnahan & Reiss, 1991; Aron & Burnstein, 2003; Xiao & Orazem, 2009; Kolko, 2010), we provide further empirical support by calculating regression estimates for this relationship, relying on 2011 data only. The results are reported in table 1.

In the first three regressions, we stick with the standard definition of broadband Internet both to set the measures of availability (number of ISPs) and residential penetration (% of residential fixed connections). From specification (1), we see that an additional ISP predicts an approximate increase in residential penetration of 0.53 percentage points. By adding state fixed effects in specification (2) the fit becomes better ($\bar{R}^2 = 0.32$) and the result changes little. If we control for population density, as in specification (3), the fit improves marginally, ($\bar{R}^2 = 0.35$) but the predicted increase in residential penetration decreases to 0.21 percentage points. In the latter three regressions, we use a more conservative definition for broadband residential penetration, only considering connections with speeds of at least 768 Kbps downstream and greater than 200 Kbps upstream. This alternative measure became the FCC's official definition of broadband in December 2008.[14] On specifications (4)-(6), an additional ISP predicts an increase of respectively 0.62, 0.59 and 0.23 percentage points in broadband penetration, again observing a better fit after adding dummies for states ($\bar{R}^2 = 0.35$) and controlling for population density ($\bar{R}^2 = 0.39$). In all cases, estimates are highly statistically significant ($p$-value $< 0.000$), which suggests that broadband availability can be a good proxy for broadband penetration.

Data on the locations of protesting activities during the Occupy movement was compiled

[12] Subsequent results presented in this paper remain unchanged when using the FCC Form 477 from June 30th, since there is very little variation between the data recorded in both spreadsheets.

[13] The wider range of the count of the number of ISPs in the original dataset, in comparison to the one of residential fixed connections, was a main motivation for such choice. The FCC records broadband penetration by allocating each county into one of six categories based on percentage of households with fixed connections, which are: zero, up to 20%, 20% to 40%, 40% to 60%, 60% to 80%, and greater than 80%. On the other hand, the count for number of ISPs operating in a given county, in our sample, ranges from 1 to 55 (or 2 to 110, after rescaling). This approach was also considered in Kolko (2012), Jaber (2013) and Miner (2015).

[14] See statement of Chairman Kevin J. Martin on that matter at https://apps.fcc.gov/edocs_public/attachmatch/FCC-08-89A2.pdf. In 2010, a new benchmark was again set to 4 megabits per second (Mbps) downstream and 1 Mbps upstream, according to the Sixth Broadband Progress Report available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-10-129A1_Rcd.pdf. Most recently, in 2015, the definition was updated to speeds of 25 Mbps for downloads and 3 Mbps for uploads. See statement of Chairman Tom Wheeler at https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-10A3.pdf (all previous documents retrieved on May 4, 2015).

from a wide array of sources, namely: three collectively assembled datasets available on the News websites The Guardian, The New York Times and on Wikipedia; an interactive list from the website Occupy Directory - the most extensive list of Occupy protest locations available; event and community directories from social networks such as Twitter and Facebook; and a bulk of online news coverage. Our database accounts the incidence of protest events in exactly 500 of the 3,109 counties of the contigeous U.S. territory.[15]

A common limitation when conducting analysis on social events concerns the possible lack of comprehensibility of available data, which in most cases can be scarce and volatile. To our effort of mapping and detailing the whole wave of protests linked to the Ocuppy movement, the quality of data collection depended greatly on how well these protests were covered by local News, and how much publicity they attained through actions of its participants.[16] We conclude that our database traces, with confidence, the locations where each event took place, although the duration and number of participants in many of these events could not be recorded with enough reliability.

Our approach was so to construct a binary variable to signalize that we have enough evidence of protest activities in a given county $i$. We consider the following mechanism to transform information from the data into evidence, in order to avoid possible false-positives: first, we cross referenced data from the aforementioned collaborative lists and the Occupy directory list. Next we validate each single recorded event with further evidence such as News coverage, strong social media activity, testimonials, photos and videos. The result for this effort can be seen graphically in figure 1.

Black dots in the figure correspond to the centroids for the counties where $Protest_i = 1$. They correspond to the counties for which we have sufficient evidence that public demonstrations have been carried out as part of the Occupy movement.

To construct the instrumental variable $Elevation_i$, we calculate a measure of mean land elevation for county $i$, in meters, using a GIS software. The raster map we utilized was a 30 arc-second DEM of North America of the GTOPO30 package, created from a collaborative work led by the U.S. Geological Survey's Center for Earth Resources Observation and Science (USGS/EROS).[17] Figure 2 displays the variation of land elevation in the U.S. territory, with

[15] We exclude Alaska, Hawaii and Puerto Rico from our sample, as their geographic placements make them outliers. OLS results are nevertheless robust to the inclusion of these observations.

[16] A widely utilized database for domestic conflicts events is the Cross-National Time Series Data Arquive, a service launched by Professor Arthur S. Banks from the State University of New York in 1968, yearly updated since then. While adequate for many cross-country studies, finer-level data for a single set of events within a country such as the Ocuppy movement is not comprehensively available. In a similar effort, the SPEED project from the University of Illinois at Urbana-Champaign attempted to record and geo-reference every civil unrest event in the world after World War II, but updates to the data are currently discontinued.

[17] Institutions also involved in the mapping of North America's DEM, as cited by the USGS/EROS: National Aeronautics and Space Administration (NASA), the United Nations Environment Programme / Global Resource Information Database (UNEP/GRID), the U.S. Agency for International Development (USAID), the Instituto Nacional de Estadistica Geografica e Informatica (INEGI) of Mexico, the Geographical Survey Institute (GSI) of Japan, Manaaki Whenua Landcare Research of New Zealand, and the Scientific Committee on Antarctic Research (SCAR).

darker areas corresponding to higher elevation.

Finally, to construct our matrix of control covariates $X_i$, we use 2011's 5-year estimate data from the American Community Survey, which are the best estimates available for demographic characteristics between decennial censuses. When any needed information is missing from these estimates, we turn to the Census data of 2010. Our choice of controls reflects the existing state of knowledge in the literature with respect to variables that may influence civil unrest and broadband supply and demand. These are: population per square mile, median age, median income, gini index, % high school graduates, % urban households, % male, % white, % black, % Hispanic, % unemployed, % high income (above $150k a year), % below poverty line and % between 18 and 24 years old. As additional covariates, we also use additional data from the Census TIGER database to calculate the mean density of roads and highways in each county using a GIS software, and data from Dave Leip's Atlas of U.S. Presidential Elections to calculate measures for elections turnout and political competition in each county.[18]

For additional specifications, we use data on climate statistics (average daily precipitation and average minimum air temperature, more precisely) for the period between October and November 2011 from the North America Land Data Assimilation System (NLDAS) and data on 3G coverage compiled from AT&T press releases available on its website. Each time a 3G installation was completed, AT&T issued a press release announcing the cities where it had extended coverage. Coverage for 2011 was then recovered using press releases available prior to the Occupy events, and the cities indicated in them. Since our analysis is at the county-level, we followed a conservative approach and constructed a binary variable, assigning unity to a county if any city contained in it had 3G coverage by 2011.

# 5 Results

How great could broadband availability have influenced the spread of Occupy-related demonstrations in the U.S.? We address this question next with separate subsections containing: (a) a preliminary analysis of our data; and (b) our main results, with a brief discussion on the magnitudes of our findings.

## 5.1 Preliminary Analysis

We start by analyzing differences in county characteristics conditioned to protests evidence status. This should help us trace preliminary assumptions on the profile differences between

[18]Election turnout is defined as number of casted votes in the 2008 presidential election divided by the number of enfranchized citizens in that occasion. To measure political competition, we follow Fergusson & Vargas (2013) and apply the formula:

$$1 - \left( \frac{\textit{votes first} - \textit{votes second}}{\textit{votes first} + \textit{votes second}} \right) \tag{6}$$

where *votes first* is the number of votes obtained by the top candidate in county $i$ and *votes second* are the votes obtained by the runner-up.

counties that had or did not have Occupy-related demonstrations. In table 2, we partition our sample between counties where $Protest_i = 1$ and $Protest_i = 0$ and report means for the collected set of demographics and additional characteristics. $t$-statistics for the difference between averages are also reported in the table.

As presumed, the means of our indicators for broadband penetration and availability are remarkably higher in the sub-sample where $Protest_i = 1$. The difference in the percentage of residences with fixed connections is 14.97 p.p. for one-way connection speeds exceeding 200 kbps and 17.56 p.p. for connection speeds of at least 768 kbps downstream, and the average number of ISPs is almost two times bigger. For our measure of land elevation, the difference in means between both partitions is statistically indifferent from zero, suggesting that our instrument is balanced in the full sample.

Comparisons on demographics also indicate that the partition where $Protest_i = 1$ is, on average, more densely populated, more urbanized, more educated, younger and wealthier, and that differences in gender predominance, ethnicity and unemployment level are only slightly perceptible. Also minimal are the differences in averages of Gini index (which is indistinguishable from zero) and in the percentage of the population below poverty line - a curious fact considering that awareness to wealth inequality was one of the main concerns in the Occupy Movement's declared agenda.

Looking at differences in mean road density, we see that counties where $Protest_i = 1$ are, on average, better served with transportation infrastructure. Data for the 2008's presidential election shows that the Democratic Party received a significantly higher share of votes where $Protest_i = 1$, suggesting likelihood of political bias to liberal ideology in such counties. It also shows that turnout was the same, on average, between partitions (suggesting no difference in political participation through the traditional channel of voting) and that political competition in the sample where $Protest_i = 1$ was marginally higher. Weather and climate data differs little across both partitions, but on average there was less precipitation where $Protest_i = 0$ between the months of October and November 2011. Finally, data on 3G suggests that coverage was also narrowly higher where $Protest_i = 1$.

In figure 3, we estimate the effect of variations in mean land elevation on both broadband availability and protest occurrences using nonparametric local polynomial estimators, along the lines of Brückner & Ciccone (2011). This allows us to detail the direction and magnitude of these effects for various sections of the data, and see if it conforms with our reasoning for these effects from section 3. Figure 3a presents estimates of the effect of elevation on the number of ISPs, using a Epanechnikov kernel and choosing the bandwidth that minimizes the mean-square error.[19] With a fair level of precision, this relationship is revealed as monotonically increasing along the whole length of observed variations in mean elevation. Figure 3b uses the same approach to obtain estimates of the effect of elevation on protests. This relationship also turns out to be monotonically increasing, although the trend is very imprecisely estimated for

[19]To choose the bandwidth, we use cross-validation (CV) criteria (see Bowman & Azzalini, 1997)

large negative variations in mean elevation since less than 1 percent of observations on mean elevations are to the very left side of the accounted values.

### 5.2 Main Results

Regressions results of protests on broadband availability is displayed in table 3. Coefficients are positive and statistically significant at the 1% level across every specification, with robust standard errors reported in parentheses. The results from Probit and OLS estimates with no additional controls (columns 1 and 2, respectively) are fairly similar, supporting the decision of focusing our attention on linear specifications. Adding controls for county-level socioeconomic demographics and dummies for state fixed effects (column 4) improves the fit ($\bar{R}^2 = 0.42$) and gives us smaller but more reliable results: the presence of one extra ISP in the broadband market of a given county is associated with an increase in the probability of an Occupy-related protest to occur in that county by about 1 p.p. In column 5 we add the control for road density and in column 6 we add all the political controls. Although their effects in the outcome are significant, they are not confounders to our previous estimate.

Moving on to our IV framework, table 4 provides us second-stage estimates of our preferred set of specifications, which include state dummies and demographic controls. Considering the specification in column 1 as our benchmark, the effect of broadband on civil unrest is higher than the ones in our previous strategy: point estimates indicate that the entrance of one new ISP in the broadband market of a given county would cause an increase in the probability of an Occupy-related protest to occur in that county by about 2.5 p.p. This impact remains after adding the control for the density of roads and highways and the political controls in the specification of column 3.

To tackle possible violations to the exclusion restriction, we add further covariates to control for possible undesired effects that link land elevation to the occurrence of the Occupy protests outside the channel of broadband Internet availability. In column 4, we add controls for average daily precipitation and average minimum air temperature. Results obtained suggest that the effects of temperature and precipitation indeed reduce the magnitude of our previous findings, although they remain high and statistically significant at the 1% level: one extra ISP in a given county accounts for a rise of 1.9 p.p. in the chance of a local protest happening. In column 5, we run the same model with also a control variable for 3G coverage, and do not observe significant changes in our results.

Our next step is to investigate the uncovered effect over different decompositions in our data. In table 5, we report the impact of broadband on protest separately for each of the four different Census Bureau-designated geographical regions in the U.S. Every estimate was obtained using our most conservative specification, which includes dummies for states, demographic controls and all of the additional controls used in table 4. In the Midwest and in the Northeast (Columns 1 and 2, respectively), the effect is positive, but variance is too high and results are not significant. Although the sub-sample for the Northeast is quite small (217 observations), is interesting to notice that our results are not derived from the region that comprises the counties on the surroundings of New York City - where the Occupy Movement first started. Even though states such as Massachusetts, Pennsylvania and New Nork have had numerous Occupy demonstrations. For the South (column 3) and the West (column 4), results are positive, significant and similar in magnitude to our previous findings. These regions also comprise states that were strongly participative to the demonstrations such as Florida, Texas and California.[20]

To summarize, our OLS estimates suggest that the probability of an Occupy-related protest to occur in a county increases by approximately 1 p.p. with the addition of one extra ISP, in our preferred specification, and by approximately 1.9 p.p. in our most conservative IV specification. To assess the magnitude of such findings, we may consider some back-of-the-envelope calculations from sharper variations in the number of ISPs operating between counties. If one extra ISP influences the probability of the occurrence of a protest by 1.5 p.p. (a middle ground between the results from the most conservative OLS and IV results), and supposing that a linear relation is not implausible for lower sections of the data, then 20 extra ISPs would, on average, account for an increase in 30 p.p. in that probability, in comparison to a county which have none.[21] In fact, 48% of the counties where Occupy protests were evidenced through the available data ($Protest = 1$) had more than 20 ISPs by the time of the protests. We can therefore conclude that our estimates are credible and should give a reliable picture on how important was the role played by availability of broadband Internet in helping disseminate the Occupy protests in the U.S.

# 6 Robustness

We give further support to the results obtained in the previous section by performing some additional tests with alternative outcomes and/or identification approaches. Some of the datasets we use are complementary to the ones described in Section 4, and in each case we briefly describe them in more detail.

[20]Results remain robust for the South when we exclude Texas and and Florida from the sample, but looses significance for the West when we exclude California. This could be to lack of variance due to an even smaller resulting sample (the number of observations drop to 355) but also suggest that California could be the main driver of the estimated effect for that sparsely-populated region. In section 6.1, we conduct this analysis only for California, using data in the city-level.

[21]If we also consider that one extra ISP is associted to an increase of 0.5 p.p. in actual broadband penetration, as suggested by estimates in table 1, then these same calculations imply that that if broadband penetration increases by 10 p.p., this would also translate to an increase of 30 p.p. in the probability of an Occupy demonstration.

## 6.1 City-level analysis in California

Our first exercise is to evaluate the effect of broadband Internet on the Occupy protests using more disaggregated data for the state of California.

The diffusion of the Occupy Movement was remarkably more extensive in California than in any other U.S. state. Several reasons may have contributed to this. In late 2011, California, as the rest of the country, was recovering from the major economic downturn engendered by 2008's financial crisis and home mortgage meltdown, which continued to impact the civil society in many ways. Markets were stagnant, unemployment was high and education costs were an increasing burden to a significant share of the population. Beyond that, the state of California is known for its strong political culture and historical sympathy for social causes and liberal values, which adds the possibility that the greater activism and participation in the Occupy protests could have had a more culture-rooted significance in California than other regions in the U.S.

Occupy-related activities in California were typical to the ones carried out in other parts of the country, with campsites and other forms of collective gatherings first happening in large cities such as Los Angeles, San Francisco and Oakland, and then rapidly spreading to many other smaller cities and towns. Some of these events, however, received greater repression from local authorities, as we exemplified in section 2.

To our advantage, the greater incidence of Occupy-related events in California provided us enough evidence and variation of protest incidence to conduct analogous exercises from previous sections in more disaggregated units of observations for this specific state – namely, to city- and town-levels. Previously, for California, we registered that in 40 of its 58 counties there has protests activities related to the Occupy Movement. Using the same mechanisms for data collection described in Section 4, it was possible to assign evidence of protests to 76 of its 480 cities and towns.[22] The difference in detail between the two measurements can be appreciated in figure 4.

In our varying specifications we include dummies for counties and demographic controls at the place-level, which are also attainable in the 2010's U.S. Census and from ACS's 5-year estimates for 2011. Unfortunately, the Number of ISPs are not provided by the FCC at the place-level, although it is available at the zip-code level - an even finer level of disaggregation. Since zip-code boundaries do not necessarily overlap with place boundaries, our approach was to assign places to zip-codes based on the centroid location of the latter, and then retrieve the maximum number of ISPs of a zip-code contained in a place.

In table 6, we show results for different specifications using Probit, OLS and the IV strategy. Results are once more consistent with previous analysis. OLS estimates with county dummies and demographic controls indicate that an extra ISP increase the probability of having protests

[22] According to the 2010 U.S. Census, California has 1523 incorporated places, which consist of 21 towns, 459 cities and 1043 census-designated-places (CDPs). We exclude the latter from our sample since these are defined by the U.S. Census Bureau for statistical purposes only and posess no legal status for their boundaries.

in 1.8 p.p., on average, in a given town or city. Also, in the IV specification, estimates are sensibly magnified, indicating increasing an effect of about 3 p.p.

## 6.2 Alternative Methods for Identification

An alternative empirical strategy employed when there are no external sources of identification or the instrumental variables are weak or unconvincing involves exploiting heteroskedasticity in the first stage regression to internally construct instruments. In a triangular system such as the one presented in equations (7)-(9), where error correlations are due to an unobserved common factor, identification comes from having regressors uncorrelated with the product of heteroskedastic errors (Lewbel, 2012).

In our case, one may imagine $U$ as an omitted variable which supposedly affects both the endogenous variable $Internet$ and $Protest$, and $V_1$ and $V_2$ are idiosyncratic errors. It is shown that in a system of the form displayed below we can properly identify the causal effect of $Internet$ on $Protest$, denoted as $\beta$, using a modified two-stage least squares (2SLS) or the generalized method of moments (GMM). All that is required for identification and estimation are the moments shown in equation 9 along with some heteroskedasticity in $\varepsilon_2$, where $Z \subseteq X$ (for a formal presentation, see the Appendix of Lewbel, 2012).[23]

$$Protest = X'\beta_1 + \beta Internet + \varepsilon_1, \quad \varepsilon_1 = \alpha_1 U + V_1, \tag{7}$$

$$Internet = X'\beta_2 + \varepsilon_2, \quad \varepsilon_2 = \alpha_2 U + V_2, \tag{8}$$

$$E[X\varepsilon_1] = 0, \quad E[X\varepsilon_2] = 0, \quad Cov[Z, \varepsilon_1\varepsilon_2] = 0. \tag{9}$$

This method is not without caveats and of course provides less reliable estimates when compared to strategies based on standard exclusion restrictions. However, given any concerns regarding the validity of the external instrument, which is inherent to empirical research, we employ Lewbel's method as an alternative identification scheme to estimate our causal effect of interest. Some empirical studies have shown that using this estimator yields results that are close to estimates based on traditional instruments. Emran & Hou (2013), for example, presents evidence on the effects of access to domestic and international markets on per capita consumption of households using data from rural China. Their results using standard IV are quite similar to the ones using Lewbel's approach. Similar results were found by Drichoutis et al. (2012), when studying the effect of food away from home expenditures on obesity among the older population in Europe, and recently by Tigre et al. (forthcoming), when investigating the impact of commuting duration on students' performance.

Results are presented in table 7. Following Lewbel (2012) and Emran and Hou (2013), we first use the Breusch-Pagan test for heteroskedasticity in the first stage regression (eq. 8) and reject the hypothesis of homoskedastic error (p-value $< 0.000$), a necessary condition for us to

[23] If $Cov(Z, \varepsilon_1\varepsilon_2) \neq 0$ treatment effect bounds on parameters can still be obtained as long as this covariance is not too large.

carry on with this empirical exercise.

We consider two approaches using Lewbel's procedure. The first only considers the heteroskedasticity generated instrumental variables (HGIV), assuming we have no instrumental variable at our dispose. The second adds our instrument to the set of generated instruments used in the estimation (IV+HGIV). Estimates using both methods yield similar results, adding robustness to our analysis. The coefficient using US data varies from .0166 to .0158, depending on whether we use only generated instruments or using all instruments available, all statistically significant at 1 percent. When using data for the state of California, coefficients vary from .0164 to .0157, all statistically significant at 1 percent. Also, these estimates are qualitatively similar to OLS and IV, which further reinforces our analysis.

As a final procedure, we consider the methodology recently developed by Oster (forthcoming) to estimate, along the lines of Altonji et al. (2005), the degree of selection on unobservables relative to observables that would be necessary to explain away the entire treatment effect we estimate. The test consists of using the information contained in the change in coefficient and the change in R-square when moving from uncontrolled to controlled regression to inform about remaining bias from unobservables. Mian & Sufi (2014) provide a recent application of Osters' test to analyze the robustness of the effect of housing net worth shock on non-tradable employment to omitted variables.

We perform this test by calculating the degree of selection on unobservables relative to observables ($\delta$) which would produce $\beta = 0$. Note, however, that calculating this number requires knowing the value of $R_{max}$, the R-square of the model controlling for the full set of covariates (observed and unobserved regressors), which is not observed. Oster argues that there must exist some randomness in the movements of the outcome variable leading $R_{max}$ to be smaller than one.[24] Considering first an $R_{max} = .7$, we obtain a value of 2.086 for $\delta$. This implies that the effect of unobservable variables on the estimated treatment effect of Internet on protests would have to be 2.086 times stronger than the effect of the observable variables in order to explain the entire negative effect we obtain for our treatment variable. We believe that this is rather unlikely. To give an idea, in Oster (forthcoming) analysis of the impact of maternal behavior on child outcomes, the value of $\delta$ obtained is 1.37, with $R_{max} = .7$. This significant effect obtained through her method is validated when compared to a huge set of well-established results. To add even more credibility to our claim, we further increase $R_{max}$ to the very unlikely value of 1 and obtain a value of $\delta$ equal to 1.337, reinforcing our causal claim.

## 6.3 Falsification Tests with Election Data

Our final set of exercises are falsification tests. As we stated in section 1, the cross-section character of our data on protesting activity in the U.S. prevents us from designing placebo tests on the effect of broadband Internet for periods before its actual inception in the U.S.

[24]See Oster (forthcoming) for definitions.

market. We attempt to overcome this deficiency by providing some additional evidence to our previous findings using data on presidential elections in the U.S.

Elections are the standard mechanism for political participation in any democratic country. The act of voting, like the act of protesting, is in its essence a way of voicing out personal views and ideologies in respect to what is better for society, through the sponsoring of a certain candidate and his associated political platform. As it is not compulsory in the U.S., voting also comprehends the decision to physically attend a voting station the same way a protester must also dislocate to participate in public demonstrations - although the associated risk to each activity is obviously not the same. National elections, such as the ones for choosing a president, are also particularly interesting since they speak to the political issues of the country as one whole. Therefore, it should serve as a point of comparison to investigate the aspects of a nationwide political event such as the Occupy Movement.

For the following exercises, we use data on presidential elections turnout and total population at the county-level for the period of 1948 to 2000 from Fujiwara et al. (2016), complemented with additional data from Dave Leip's Atlas of U.S. Presidential Elections for the years 2004, 2008 and 2012. We choose to focus on elections turnout for it is a conservative measure of political participation, unconditional to any specific political orientation.

In our first set of estimates, we investigate the effect of $\log(Elevation_i)$ - our instrument used in the main results section - on the difference in turnout between presidential elections at a given year ($\Delta$ Turnout, henceforth). Figure 5 displays estimates for the years between 1988 and 2012,[25] controlled for state fixed-effects and county population recorded in each year's previous Census. Vertical bars at each point estimate correspond to confidence intervals at the 95% level. Our estimates show that, for 2000 and previous years, elevation exerts no effect on $\Delta$ Turnout, with every estimated value lying tightly around zero. For the three years after 2000, these effects are *negative* with significant values for the two most recent years, 2008 and 2012.

The negative effects on $\Delta$ Turnout in 2008 and 2012 are quite noteworthy, considering that president Obama's campaign in both elections was marked by its strong online presence (Jaber, 2013) and that the 2008 presidential elections had a record-setting overall turnout within the three previous decades. In this scenario, if we are to assume that access to broadband Internet increases voter turnout (as we saw that increases the probability of protests), we must relax our previous assumption of a strictly positive effect of land elevation on broadband availability across different regions in the U.S. Whichever the case, the main message behind this result is that land elevation exerts an effect in voter turnout consistent with a positive trend in broadband deployment after the year 2000, and that such an effect is not observed for years prior to the introduction of broadband technology.

Now, did broadband Internet actually have a *positive* impact on voter turnout in the U.S.?

[25] According to reports from the FCC, broadband Internet infrastructure was introduced in the U.S. in late 1999 and begin to be implemented across the country in the year 2000. As our sample goes until 2012, we plot results between 1988 and 2012 to evaluate the effect in a window of time between three years prior and three years after 2000.

Although there is plenty of empirical research uncovering such a causal link (e.g. Larcinese & Miner, 2012; Jaber, 2013), we provide further evidence to this relationship in table 8, in which we report fixed-effects estimates of the impact of the trend in broadband deployment on difference in voter turnout in the U.S. The estimate in column 4 indicates that each new ISP is associated with an average increase of 3.7 p.p. in voter turnout from the previous year within the period of introduction and diffusion of broadband technology in the U.S. (2000-2012). On the other hand, in columns 1, 2 and 3, we take the growth of broadband Internet from period 2000-2012 as a placebo and estimate its impact in voter turnout for different election cycles prior to actual broadband introduction (1952-1964, 1968-1980 and 1984-1996, respectively). Every obtained estimate is statistically indifferent from zero.

Though we are not able to claim that political participation in the form of elections turnout should be perfectly correlated with trends in public demonstrations, such as protests, the previous results are useful to the extent that there might exist some degree of correspondence between these two. In that sense, results in this paper are complementary to other recent efforts in the literature that evaluate the impact of broadband Internet on elections, such as Jaber (2013), as we uncover a similar effect for another specific form of political participation.

# 7 Concluding Remarks

This paper provides empirical evidence that information and communication technologies (ICTs) can affect collective participation in social and political movements, in particular that broadband Internet played a significant role in disseminating protesting activity related to the Occupy movement in many counties across the U.S. territory. Our estimates across different specifications suggest that the probability of observing an Occupy-related protest in a given location increases by approximately 1 and 3 p.p. (percentage points) with the addition of one extra Internet Service Provider (which, in turn, is associated to an increase in broadband penetration of about 0.5 p.p.). Results are consistent when analyzing county-level data for the contiguous U.S., for each different U.S. region separately (Norheast, Midwest, South and West), and when analysing city-level data for California. Our findings are also robust to alternative methods for identification, such as heterosketasticity-based IV estimators, and are consistent with further insights drawn from the U.S. presidential elections, which we interpret as an alternative mechanism for political participation.

A quick survey into recently released news reveals that events of civil unrest - many of which comparable, in scope, to the Occupy Movement - are still a very present matter in international politics. For instance, there are ongoing protests against government austerity and bad policies happening in Latin America at the time of this writing. Although the role of ICTs in the dissemination of social and political movements is an interesting inquiry by itself, we believe that the thorough understanding of what sort of aggrievement exactly brings people to the streets in each situation is a very important subject for policy conduction and for the development of a better agreement between government and civil population. The growing effort to assemble data on events of civil unrest should therefore turn this into a fruitful area for future research.

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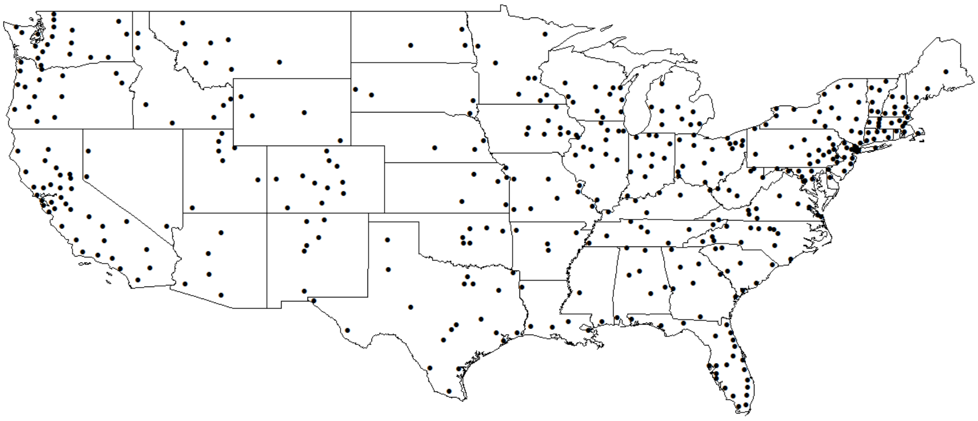
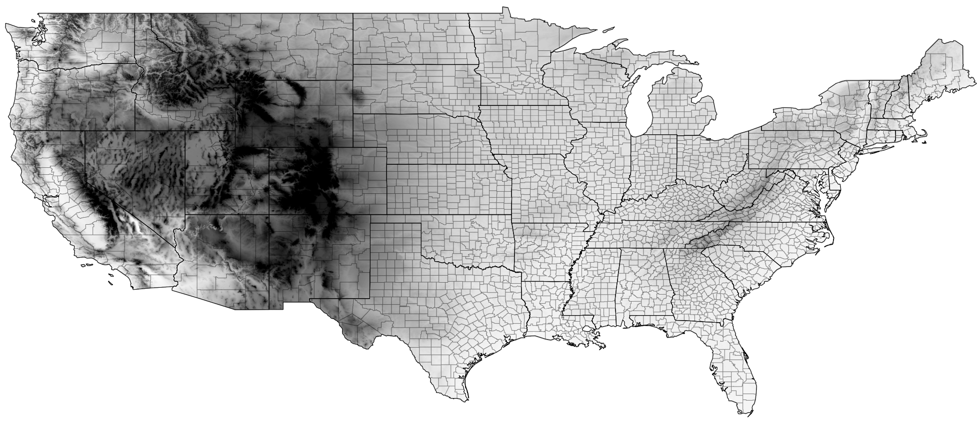
**Figure 1:** Geography of the Occupy Movement in the United States



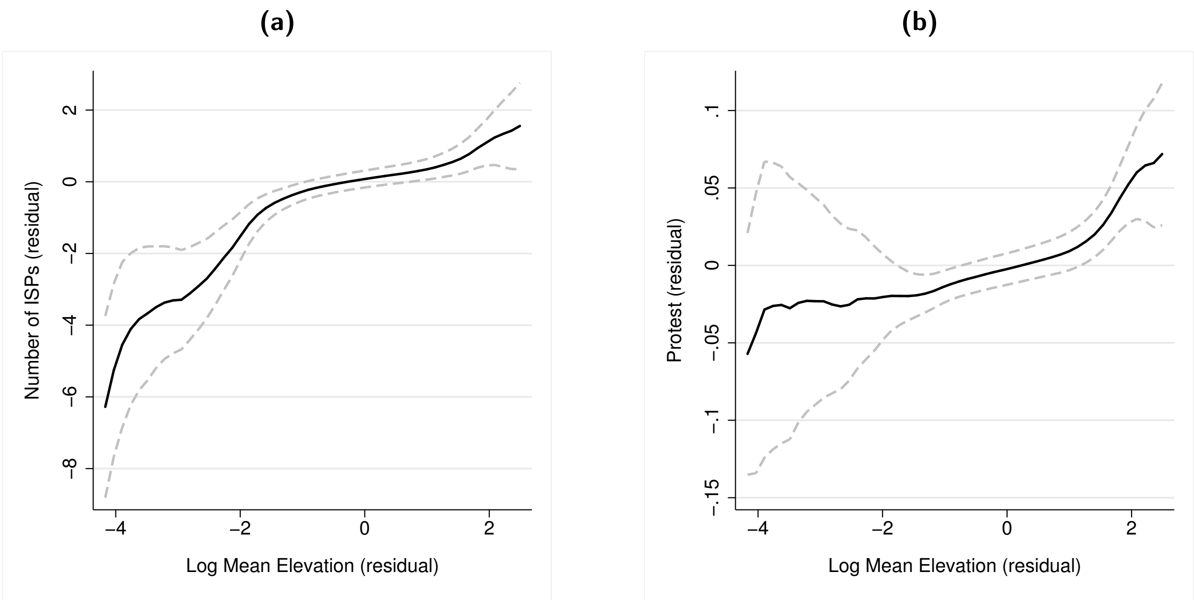
Note: black dots correspond to the centroids of counties that had protests related with the Occupy Movement.

**Figure 2:** Land Elevation in the United States



Note: Darker areas correspond to higher elevation.

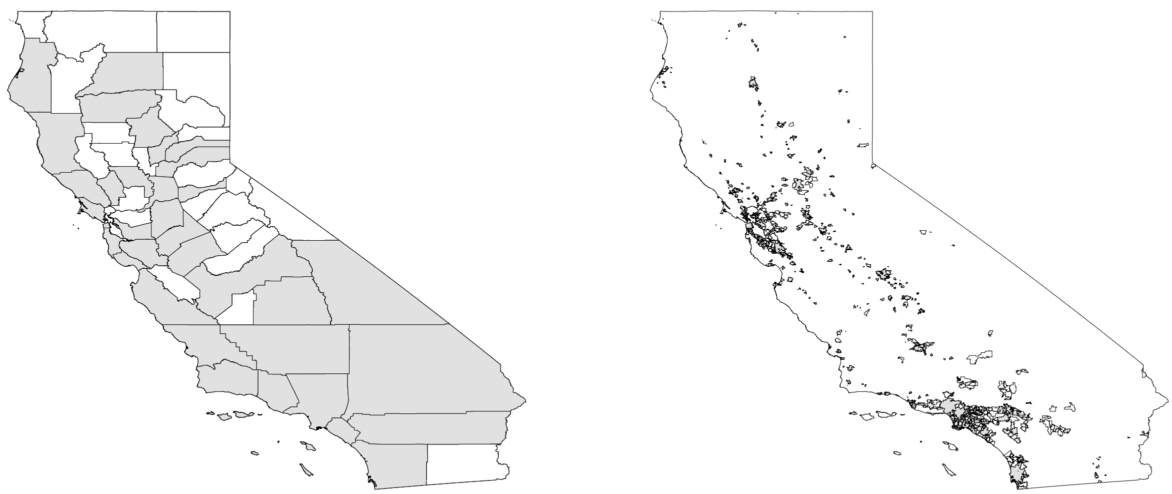
**Figure 3:** Effect of Mean Elevation - Nonparametric Local Polynomial Estimates




Notes: (a) Log Mean Elevation and Number of ISPs; (b) Log Mean Elevation and Protest. Nonparametric local polynomial estimates are computed using an Epanechnikov kernel. Bandwidth are obtained by cross-validation criteria. Dashed lines indicate 95% confidence intervals.

**Figure 4:** Geography of the Occupy Movement in California

**(a)** **(b)**



Notes: (a) counties in California; (b) places in California, excluding census-designated places. Counties and places in gray had Occupy-related protests.

**Figure 5:** Log Elevation and Δ Voter Turnout

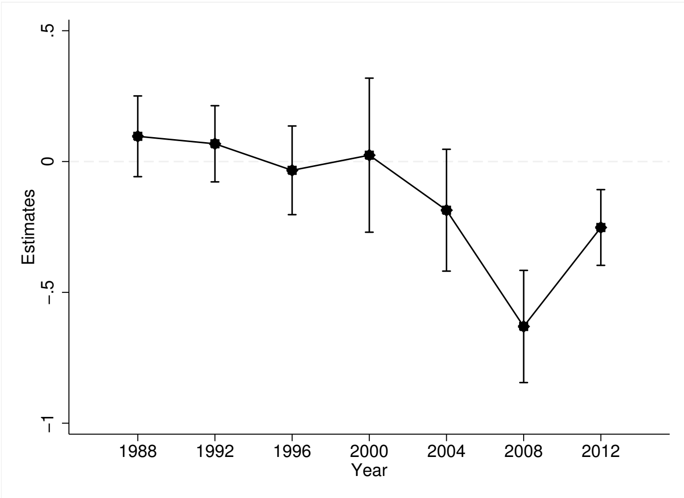


**Table 1:** Relationship between Broadband Penetration and the Number of ISPs

| | Dependent variable: % of R.F.C. 200 kb/s + | | | Dependent variable: % of R.F.C. 720 kb/s + | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of ISPs | .53*** | .50*** | .21*** | .62*** | .59*** | .23*** |
| | (.02) | (.02) | (.03) | (.02) | (.02) | (.03) |
| Log Pop. Density | | | 3.32*** | | | 4.27*** |
| | | | (.30) | | | (.33) |
| State dummies | **No** | **Yes** | **Yes** | **No** | **Yes** | **Yes** |
| $R^2$ | .19 | .33 | .36 | .21 | .36 | .40 |
| N. of Counties | 3,019 | 3,019 | 3,019 | 3,019 | 3,019 | 3,019 |

Notes: Dependent variables are the percentage of the population with broadband access under two alternative definitions. The FCC divides counties into six groups on the basis of broadband penetration: 1) Zero broadband penetration, 2) 0 < broadband ≤ 20%, 3) 20% < broadband ≤ 40%, 4) 40% < broadband ≤ 60%, 5) 60% < broadband ≤ 80%, and 6) broadband > 80%. For each category, we impute the middle of the range (e.g. 10% penetration for counties in the second category). *** indicates significance at the 1 percent level. Observations are at the county-level.

**Table 2:** Summary Statistics

| | Mean | s.d. | Mean by protest status: $Protest_i = 0$ | $Protest_i = 1$ | $t$-stat |
|---|---|---|---|---|---|
| | | | Panel A: Main Regressors | | |
| · FCC data | | | | | |
| % Residential Fixed Connections (200 kbps +) | 55.27 | 15.91 | 52.87 | 67.84 | 20.55*** |
| % Residential Fixed Connections (768 kbps +) | 49.62 | 17.45 | 46.80 | 64.36 | 22.19*** |
| Number of ISPs | 24.55 | 13.13 | 21.46 | 40.712 | 35.67*** |
| · USGS/EROS data | | | | | |
| Mean Land Elevation | 442.07 | 507.35 | 437.79 | 464.42 | 1.08 |
| | | | Panel B: Main Covariates | | |
| · Census/ACS data | | | | | |
| Population per Square Mile (2010) | 261.48 | 1733.25 | 134.01 | 926.64 | 9.50*** |
| Median Age | 40.14 | 4.97 | 40.66 | 37.43 | -13.68*** |
| Median Household Income | 40,925.44 | 17,134.28 | 39,933.06 | 46,103.72 | 7.44*** |
| Gini Index | 0.44 | 0.04 | 0.44 | 0.43 | -0.95 |
| % High School | 83.63 | 7.16 | 82.94 | 87.25 | 12.62*** |
| % Urban (2010) | 40.61 | 31.49 | 33.87 | 75.72 | 31.17*** |
| % Male | 49.93 | 2.30 | 50.05 | 49.29 | -6.75*** |
| % White | 84.24 | 16.13 | 84.86 | 81.01 | -4.90*** |
| % Black | 9.04 | 14.58 | 9.30 | 9.10 | 0.10 |
| % Hispanic | 8.10 | 13.09 | 7.40 | 11.76 | 6.88*** |
| % Unemployed | 4.80 | 1.90 | 4.70 | 5.33 | 6.93*** |
| % High income | 4.75 | 3.90 | 4.25 | 7.37 | 17.15*** |
| % Below Poverty Line | 15.90 | 6.41 | 16.04 | 15.16 | -2.81*** |
| % 18 to 24 Years Old | 8.94 | 3.77 | 8.45 | 11.49 | 17.30*** |
| | | | Panel C: Additional Covariates | | |
| · Census TIGER data | | | | | |
| Mean Road Density | 3.92 | 2.90 | 3.57 | 5.74 | 15.98*** |
| · Dave Leip's Elections 2008 data | | | | | |
| % Voter Turnout | 58.90 | 9.41 | 58.81 | 59.34 | 1.14 |
| % Democrats | 41.51 | 13.83 | 39.42 | 52.44 | 20.56*** |
| Political Competition | 0.74 | 0.18 | 0.73 | 0.79 | 7.18*** |
| · NLDAS data | | | | | |
| Average Daily Precipitation | 2.45 | 1.40 | 2.38 | 2.79 | 5.92*** |
| Average Minimum Air Temperature | 42.87 | 6.66 | 42.80 | 43.24 | 1.35 |
| · AT&T data | | | | | |
| 3G Coverage | 0.12 | 0.32 | 0.11 | 0.14 | 1.73* |
| N. of Counties | 3,109 | | 2,609 | 500 | |

Notes: Statistics for the FCC variables are based on value estimates as described in Section 4 and in ??. Mean land elevation is measured in meters above sea level. Census/ACS data are for 2011 unless otherwise reported. Mean road density is measured in kilometers of road per square-kilometer (km$^2$). Political Competition and 3G coverage are indexes calculated as described in Section 3, with higher values corresponding to higher competition/coverage. Average daily precipitation is measured in millimeters (mm) and average air temperature in Fahrenheit (F). $t$-statistics are calculated from the difference between means by protest status, where * indicates significance at the 10 percent level and *** indicates significance at the 1 percent level. All variables are at the county-level.

**Table 3:** Broadband Internet and Protests - Probit and OLS Estimates

| *Dependent variable:* | **Probit** | **OLS** | | | | |
|---|---|---|---|---|---|---|
| Protest | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of ISPs | .0110*** | .0151*** | .0145*** | .0098*** | .0099*** | .0100*** |
| | (.0004) | (.0005) | (.0006) | (.0008) | (.0008) | (.0008) |
| Mean Road Density | | | | | -.0067 | -.0075** |
| | | | | | (.0042) | (.0044) |
| % Voter Turnout | | | | | | .0049*** |
| | | | | | | (.0009) |
| % Democrats | | | | | | .0051*** |
| | | | | | | (.0009) |
| Political Competition | | | | | | -.1213*** |
| | | | | | | (.0430) |
| State Dummies | **No** | **No** | **Yes** | **Yes** | **Yes** | **Yes** |
| County-level Controls | **No** | **No** | **No** | **Yes** | **Yes** | **Yes** |
| $R^2$ | - | .31 | .36 | .43 | .43 | .43 |
| $\bar{R}^2$ | - | .29 | .35 | .42 | .42 | .43 |
| N. of Counties | 3,109 | 3,109 | 3,109 | 3,109 | 3,107 | 3,107 |

Notes: Probit estimates are reported in terms of marginal effects. County-level controls consist of the following county-level demographics: log(density), log(median age), log(median income), gini index, % high school grads, % urban, % male, % white, % black, % Hispanic, %income $150k+, % income below poverty line, %18 to 24 years old population. *** indicates significance at the 1 percent level.

**Table 4:** Broadband Internet and Protests - IV Estimates

| *Dependent variable:* | **Land Elevation IV** | | | | |
|---|---|---|---|---|---|
| Protest | (1) | (2) | (3) | (4) | (5) |
| Number of ISPs | .0250*** | .0272*** | .0243*** | .0185*** | .0185*** |
| | (.0064) | (.0068) | (.0062) | (.0044) | (.0044) |
| Mean Road Density | | -.0114** | -.0132*** | -.0117** | -.0117** |
| | | (.0048) | (.0050) | (.0045) | (.0045) |
| % Voter Turnout | | | .0061*** | .0055*** | .0055*** |
| | | | (.0011) | (.0010) | (.0010) |
| % Democrats | | | .0046*** | .0046*** | .0046*** |
| | | | (.0009) | (.0009) | (.0009) |
| Political Competition | | | -.1250*** | -.1191*** | -.1191*** |
| | | | (.0457) | (.0436) | (.0436) |
| Average Daily Precipitation | | | | .0107 | .0107 |
| | | | | (.0083) | (.0083) |
| Average Minimum Air Temperature | | | | -.0027 | -.0027 |
| | | | | (.0021) | (.0021) |
| 3G Coverage | | | | | .0012 |
| | | | | | (.0174) |
| State dummies | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| County-level controls | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| $R^2$ | .35 | .30 | .37 | .42 | .42 |
| $\bar{R}^2$ | .34 | .31 | .36 | .41 | .41 |
| N. of Counties | 3,109 | 3,109 | 3,107 | 3,107 | 3,107 |

Notes: County-level controls consist of the following county-level demographics: log(density), log(median age), log(median income), gini index, % high school grads, % urban, % male, % white, % black, % Hispanic, %income $150k+, % income below poverty line, %18 to 24 years old population. ** indicates significance at the 5 percent level and *** indicates significance at the 1 percent level.

**Table 5:** Heterogeneity - IV Estimates

| *Dependent variable:* Protest | Midwest (1) | Northeast (2) | South (3) | West (4) |
|---|---|---|---|---|
| Number of ISPs | .7676 | .0252 | .0184*** | .0131** |
| | (5.462) | (.0171) | (.0063) | (.0056) |
| Additional controls | **Yes** | **Yes** | **Yes** | **Yes** |
| State dummies | **Yes** | **Yes** | **Yes** | **Yes** |
| County-level controls | **Yes** | **Yes** | **Yes** | **Yes** |
| $R^2$ | - | .48 | .33 | .52 |
| $\bar{R}^2$ | - | .40 | .32 | .48 |
| N. of Counties | 1,055 | 217 | 1,422 | 413 |

Notes: County-level controls consist of the following county-level demographics: log(density), log(median age), log(median income), gini index, % high school grads, % urban, % male, % white, % black, % Hispanic, %income $150k+, % income below poverty line, %18 to 24 years old population. Additional controls consist of: % voter turnout, political competition, mean road density, 3G coverage, average daily precipitation, average minimum air temperature. ** indicates significance at the 5 percent level and *** indicates significance at the 1 percent level.

**Table 6:** Broadband Internet and Protests in California

| *Dependent variable:* | **Probit** | **OLS** | | | **L. Elev. IV** |
|---|---|---|---|---|---|
| Protest | (1) | (2) | (3) | (4) | (5) |
| Number of ISPs | .0082*** | .0084*** | .0185*** | .0180*** | .0296*** |
| | (.0016) | (.0017) | (.0030) | (.0032) | (.0048) |
| County dummies | **No** | **No** | **Yes** | **Yes** | **Yes** |
| Place-level controls | **No** | **No** | **No** | **Yes** | **Yes** |
| $R^2$ | - | .06 | .23 | .26 | .22 |
| $\bar{R}^2$ | - | .06 | .13 | .13 .08 | .10 |
| N. of Places | 480 | 480 | 417 | 410 | 410 |

Notes: Probit estimates are reported in terms of marginal effects. controls consist of the following county-level demographics: log(density), log(median age), log(median income), gini index, % high school grads, % urban, % male, % white, % black, % Hispanic, %income $150k+, % income below poverty line, %18 to 24 years old population. *** indicates significance at the 1 percent level.

**Table 7:** Heteroskedasticity-based IV estimates

| | Contiguous U.S. | | California | |
|---|---|---|---|---|
| *Dependent variable:* | **HGIV** | **IV+HGIV** | **HGIV** | **IV+HGIV** |
| Protest | (1) | (2) | (3) | (4) |
| Number of ISPs | .0166*** | .0158*** | .0164*** | .0157*** |
| | (.0012) | (.0012) | (.0060) | (.0058) |
| Additional controls | **Yes** | **Yes** | **No** | **No** |
| State dummies | **Yes** | **Yes** | **No** | **No** |
| County dummies | **No** | **No** | **Yes** | **Yes** |
| Main controls | **Yes** | **Yes** | **Yes** | **Yes** |
| $R^2$ | .45 | .45 | .25 | .25 |
| $\bar{R}^2$ | .35 | .35 | .10 | .10 |
| N. of Obs. | 3,109 | 3,109 | 410 | 410 |

Notes: Main controls consist of the following demographics for the U.S. (county-level) and California (city-level): log(density), log(median age), log(median income), gini index, % high school grads, % urban, % male, % white, % black, % Hispanic, %income $150k+, % income below poverty line, %18 to 24 years old population. Additional controls consist of: % voter turnout, political competition, mean road density, 3G coverage, average daily precipitation, average minimum air temperature. ** indicates significance at the 5 percent level and *** indicates significance at the 1 percent level.

**Table 8:** Broadband Internet and Voter Turnout

| | Placebo Effect | | | Real Effect |
|---|---|---|---|---|
| *Dependent variable:* | 1952-1964 | 1968-1980 | 1984-1996 | 2000-2012 |
| Δ Voter Turnout | (1) | (2) | (3) | (4) |
| Δ Number of ISPs | .0237 | -.0368 | .0298 | .0371** |
| | (.0191) | (.0377) | (.0190) | (.0169) |
| Clusters by State | **Yes** | **Yes** | **Yes** | **Yes** |
| $R^2$ | .37 | .06 | .53 | .23 |
| N. of Obs. | 12,336 | 12,367 | 12,400 | 12,408 |
| N. of Counties | 3,087 | 3,098 | 3,102 | 3,102 |