

Digital Access, Political Networks and the Diffusion of Democracy

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Abstract: We examine the effects of digital access on the prevalence of democracy and its diffusion via geographical and trade networks across 152 countries between 2000 and 2008. Although civil liberties and media freedom show a consistently positive relationship with different forms of digital access, our dynamic models that allow co-evolution of digital access, democracy and trade tie formation suggest that high mobile penetration has a more significant impact on civil liberties than Internet access does, and may also increase a country's "susceptibility" to democratic changes in neighboring nations. We explore possible drivers of these empirical findings, discussing some social and political implications.

Keywords: Democracy, Internet, Social media, Selection, Influence, SIENA

1. Overview and Motivation

On January 14th, 2011, President Zine El Abidine Ben Ali stepped down as the president of Tunisia, reacting to a localized series of protests that had begun in the central Tunisian town of Sidi Bouzid four weeks earlier. Over the next ten days, thousands of people in neighboring Egypt demanded the resignation of their president Hosni Mubarak, an Egyptian Facebook page was set up to coordinate protests in Cairo, and there was widespread revolutionary activity in countries that included Yemen and Algeria. These protests soon fanned out across the region, and by early February, 11,000 Syrians had joined a Facebook page called The Syrian Revolution, citizens of Yemen, Jordan, Morocco and Oman were staging public rallies, and the government of nearby Kuwait had made key interior government changes towards pre-empting demonstrations. The short-term culmination of these events was a series of protests at Tahrir Square that was covered extensively by the international press and which soon led to resignation of Hosni Mubarak on February 11th, 2011, later spawning a civil war in Libya and persistent unrest in Yemen. Regional diffusion of revolution in this way is not unprecedented. Many writers have drawn a parallel between this recent “Jasmine Revolution” or “Arab Spring” and the Spring of Nations of 1848, which began in Sicily in January, became more visible in France in February, then spread through much of Europe over the year (Evans and Strandmann, 2000)¹.

A newer and recurring theme associated with the 2011 events in Northern Africa has been a focus on the role that information technologies and social media may or may not have played in sustaining and diffusing revolutionary activity and political change. Press coverage concurrent with the events frequently emphasized the enabling role of the Internet, even going so far as to label these “Twitter Revolutions” or “Facebook Revolutions”. However, the ex-post and deeper analysis has been more cautious in ascribing any causal role to social media

¹ These revolutions were largely suppressed by the end of the year and it is generally believed that they did not lead to a great deal of reform beyond the abolition of serfdom in Austria and Hungary.

technologies, although pointing to two key aspects of information technologies – providing access to information and providing a means for coordination – as potential sources of their catalyzing effect on democratic change². For example, in a prescient Foreign Affairs article in January 2011, Clay Shirky notes that:

“The safest characterization of recent quantitative attempts to answer the question, Do digital tools enhance democracy? is that these tools probably do not hurt in the short run and might help in the long run – and that they have the most dramatic effects in states where a public sphere already constrains the actions of the government. Despite this mixed record, social media have become coordinating tools for nearly all of the world's political movements, just as most of the world's authoritarian governments (and, alarmingly, an increasing number of democratic ones) are trying to limit access to it.” (Shirky, 2011)

Similarly, Fareed Zakaria adopts a more neutral position in summarizing his view about how information technologies might affect democratization:

“It's too simple to say that what happened in Tunisia and Egypt happened because of Facebook. But technology — satellite television, computers, mobile phones and the Internet — has played a powerful role in informing, educating and connecting people in the region. Such advances empower individuals and disempower the state. In the old days, information technology favored those in power, because it was one-to-many. That's why revolutionaries tried to take over radio stations in the 1930s — so they could broadcast information to the masses. Today's

²This is not the first new technology has been connected to the diffusion of revolution; there is also conjecture that while the information transparency facilitated by the emergence of newspapers played a role in sustaining the 1848 Spring of Nations revolution within each country (Zakaria, 2011), there were no technologies for coordinating revolutionary activity across the neighboring countries (Evans and Strandmann, 2000).

technologies are all many to many, networks in which everyone is connected but no one is in control. That's bad for anyone trying to suppress information.” (Zakaria, 2011)

It is indeed too early to assess whether the revolutions in Northern Africa will lead to longer-run political reform, or whether information technologies will play a pivotal role in sustaining either the activism or any subsequent democratic change. Nevertheless, these events provide timely motivation for the question we investigate in this paper: *Is access to digital technologies related to the emergence of democracy within a country and the diffusion of democracy across countries?* Our question does not restrict our focus to short-term revolutionary activities aimed at radical political change. The emergence of WikiLeaks and the ongoing challenges faced by local bloggers in China indicate that the effects that digital technologies may have on democracy and freedom are more far-reaching than the effect social media might or might not have on fostering revolution; our question thus is broader in its scope and timeframe than one that asks, say, whether social media technologies foster the emergence and diffusion of social or political revolutions.

We find this question compelling enough to warrant further investigation because there is sufficient reason to believe that the adoption of digital technologies could lead governments in an anti-democratic direction. For example, Medina (2011) documents the attempts by Chilean President Salvador Allende to create an IBM-based computer system in the early 1970's to facilitate a more efficient planned economy; while this “Project CyberSyn” was only partially successful, there is some evidence that it was instrumental in thwarting a 1972 labor strike by 40,000 truck drivers in Santiago. Although it was common in the early days of the popular Internet to assert that the decentralized and open IP technologies it was based on would render it useless as a technology for regulating behavior, Lessig (2006) makes a compelling counter-argument in his discussion about architectures of control. To quote:

“I describe the changes that could – and are – pushing the Net from the unregulable space it was, to the perfectly regulable space it could be. These changes are not being architected by government. They are not the product of some *1984*-inspired conspiracy; they are the consequences of changes made for purely pragmatic, commercial ends.” (Lessig, 2006, p.38)

In a related vein, Nissenbaum (1998) argues that information technologies are altering the meaning of what is public information, which makes current notions of the scope of privacy increasingly limited, and consequently limits the extent to which individuals may use privacy to “sustain power, liberty, and autonomy against potentially overwhelming forces of government.” Ironically, a trend of digital convergence over the last decade may exacerbate the potential use of the Internet as a technology of control; as citizens of a country become more reliant on a single network for accessing textual information/news, video information, as well as for person-to-person voice and data communication, the potential for governments to exercise (anti-democratic) control through digital technologies grows³.

Before providing evidence that addresses our question empirically, we will (1) make the idea of “democracy” more precise, (2) discuss the connection between technological progress, different kinds of “digital access” and the emergence of democracy, and (3) briefly mention the different networks over which such diffusion, if it exists, might occur.

³ This does not have to take the form of a complete Burma or Egypt-style Internet shutdown. Rather, control of the kind wherein only specific kinds of Web-based information are available to its citizens might be equally detrimental to democracy. In a future where Internet-based news is the only available news, this form of control can be quite powerful, and since Web browsing creating the illusion of user control and choice, even more so.

First, although the term is generally associated with direct participation, political equality and popular sovereignty, there are a number of different conceptions of “democracy”. In arguing against the use of definitions of democracy based on outcomes and in favor of definitions based on how the government is chosen and functions, O’Loughlin and his co-authors suggest that economic freedoms and political freedoms must be treated as distinct, and when confounding a definition of democracy with its desired outcomes, one risks losing analytical leverage. Similarly, Zakaria (1997) notes that to define democracy as meaning “‘a good government’ renders it analytically useless.” These issues notwithstanding, our objective in this paper is to study the effects of networks and digital access on democracy itself, rather than the effect of democratic institutions on their intended outcomes, and we therefore lean towards measures that are both procedural and substantive definitions. This is consistent with the thinking of Zakaria (1997) who argues that defining democracy merely based on how a country chooses its government may be too narrow and citing the emergence of a number of “illiberal democracies”, countries whose governments might be chosen using democratic procedures, but whose citizens lack basic liberties of speech, assembly and religion. A similar contrast is drawn by Diamond (2008) between “thick” and “thin” democracies. This distinction between *political rights* and *civil liberties* motivates including some measure of both in assessing the “level” of democracy in a country. We are particularly interested in changes in civil liberties that relate to freedom of expression, the right to associate freely, and personal autonomy, since intuitively, these are most likely to be altered directly by changes in citizens’ digital access. We also consider a third measure of democracy, namely *media freedom*, since it is possible that the path via which digital access leads to a change in civil liberties or political rights is through its impact on freedom of the media; indeed, there is a long-standing belief that a free press is an essential precursor to a strong democracy (McChensky and Nichols, 2009).

Next, there is a healthy history of conjecture about the connection between technological progress and the emergence of democracy. As Langdon Winner points out:

“An eagerness to interpret technical artifacts in political language is by no means the exclusive property of large-scale, high-technology systems. A long lineage of boosters has insisted that the biggest and best that science and industry made available were the best guarantees of democracy, freedom and social justice. The factory system, automobile, telephone, radio, television, space program, and of course nuclear power have all at one time or another been described as democratizing, liberating forces.” (Winner, 1986)

Glancing through recent examples suggests that while the connection between digital access and democracy could be real, it is unlikely to conform to a return to an Athenian style of democracy with direct participation by citizens (Giridharadas 2009) and the elimination of the need for representative government, and more likely to resemble the transparency and coordination effects visible during the events in Northern Africa in 2011. For example, Goldstein (2007) documents the use of mobile ‘phones and web-based discussion boards in fostering the Orange Revolution of 2004 in Ukraine. Faris and Etling (2008) discuss the how the Burmese government shut down the Internet in their country for two weeks towards quashing the 2007 “Saffron Revolution”. In trying to mirror this strategy partially, the Egyptian government made numerous attempts to shut down protestor communications technology in 2011, blocking Twitter and mobile usage on January 25th, blocking Facebook, shutting down Blackberry and cutting network access at Tahrir Square on January 26th, and eventually shutting down all Internet services on January 27th.

The “revolutions” that digital access might affect need not be aimed at radical political change; similar examples have conjectured the role played by decentralized digital technology in changing the course of elections in South Korea in 2002 and the United States in 2008. Furthermore, as argued by Zhou, Wellman and Yu, it seems important to look beyond the explicit effects that social media may or may not have on events like the resignation of Mubarak; implicit

effects like fostering “networked individualism” may actually have a greater effect on longer-run and more permanent democratic change (Zhou et al. 2011).

Two recurring themes in each of these (and earlier) examples of digital democratization are that the technology in question played one or both of two roles: enabling greater information access or transparency, and facilitating the coordination of activities between geographically dispersed citizens⁴. The most striking recent example of information technology’s effect on government information transparency can be found by examining the myriad documents that have been made available by Julian Assange’s WikiLeaks, which is made possible by a network of servers on the (traditional) Internet. A related kind of transparency is facilitated by the network of mobile phone users on the Usha Hidi platform, which has been instrumental in documenting ethnic violence in Kenya and making this information more accessible.

Access to information and the ability to coordinate are familiar as the underlying transformative effects of information technologies on organizations and markets (Gurbaxani and Whang 1991). While we do not attempt to parse these effects separately in our analysis, they motivate us to adopt a broader definition of “digital access” to include not just Internet access but access to other technologies for information access and coordination, including landline telephones and mobile ‘phones. The inclusion of the latter is further motivated by recognizing that for a vast majority of the industrializing world, the mobile Internet will be the only Internet, and mobile ‘phone adoption is a precursor to broader digital access. A series of prior studies that have examined the connection between digital access and the emergence of democracy often include both information and communications technologies: for recent examples, see Grolshek (2010) or Howard (2010) and the references they cite.

⁴ Faris and Etling (2008) provide an excellent and detailed analysis of the different ways in which digital access might contribute both positively and negatively to democracy.

Finally, there are a number of ways in which different countries are linked to one another and it is conceivable that any one of these networks of links could serve as a long-run conduit for the forces of democracy. Our opening example clearly motivates the role a geographic network might play as a channel of this kind. A similar basis for diffusion was used by O’Loughlin et al. (1998) who find evidence of both temporal and spatial clustering of democracy during the period 1946-1994. Geographic proximity also plays a role in how Internet technologies might alter access to information: Blum and Goldfarb provide quantitative evidence of this linkage, showing that for taste-dependent digital content, a 1% increase in the physical distance of the country a web site is based in from the country a user resides in reduces website visits by 3.25%. This connection notwithstanding, since the diffusion of democracy across countries, if it occurs, will be driven largely by the spread of ideas and information, it is likely that non-geographic networks that facilitate this spread will play an equally important role. A proxy we use for this kind of “idea” network is a network based on trade flows between countries, which while clearly not mirroring the flow of information or ideology, serves as a reasonable approximation.

2. Data

Our analysis uses a panel comprising data about annual measures of democracy, digital access, trade flows, political institutions, and economic development which we construct for 152 countries between 2000 and 2008. The countries we exclude did not report trade data or digital access data for at least one year during the analysis period.

Democracy. Our three primary measures of democracy are political rights (PoliticalRights), civil liberties (CivilLiberties) and media freedom (MediaFreedom), all of which are obtained from Freedom House (<http://www.freedomhouse.org>), an independent watchdog organization that specializes in the analysis of the components of freedom.

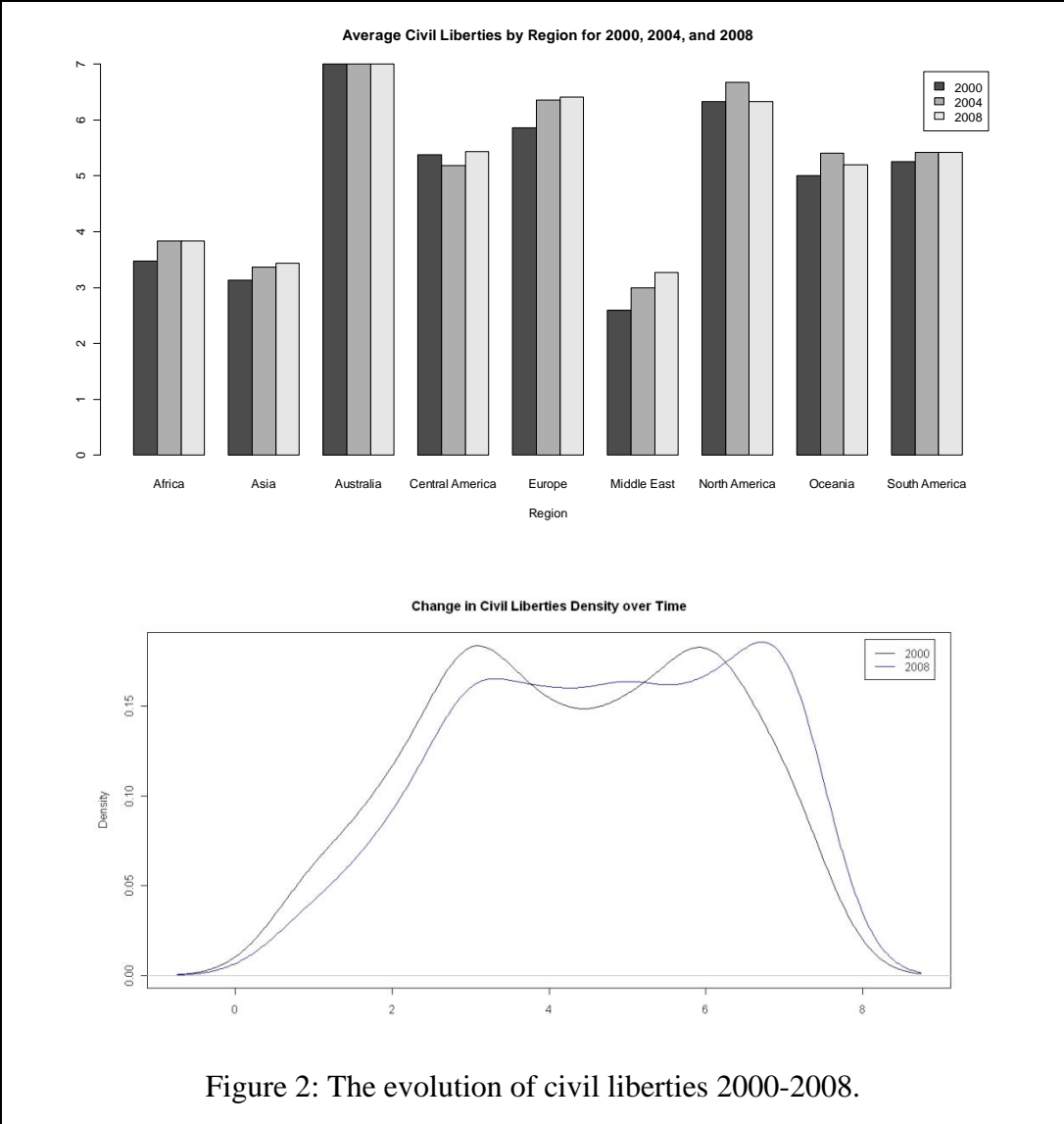


Figure 2: The evolution of civil liberties 2000-2008.

The measures of civil liberties and political rights are obtained from their annual “Freedom in the World” reports from 2000 to 2008. Freedom House rates countries based on a 25-question survey, of which 10 are about political rights and 15 are about civil liberties. The questions contributing to their measures of political rights are designed to assess the electoral process, political pluralism and participation, and the functioning of government. The civil liberties questions assess freedom of expression, rule of law, right to associate freely, and personal autonomy. The survey yields a score between 0 and 40 for political rights and a score between 0 and 60 for civil liberties, which are then converted to normalized scores on a 7-point scale, with countries with the highest civil liberties or political

rights receiving a 7 as their respective rating⁵. A summary of the evolution of average assessed civil liberties is provided in Figure 2. Our measure of media freedom is obtained from Freedom House's annual Freedom of the Press Index which gauges the autonomy of the press across the world. The composite index is created by surveying overseas correspondents and staff members regarding the legal, political, and economic environment and its influence on media content.

Digital Access. Our primary measures of digital access—mobile phone subscribers and Internet subscribers—were gathered from the World Telecommunications and ICT Indicators database of the International Telecommunication Union, a United Nations agency (<http://www.itu.int>). The variables we use are:

- **MobileDensity.** The number of subscribers to portable mobile telephone service divided by the de facto population (defined below), expressed as a percentage between 0 and 100. Since subscribers may not be isolated precisely in the ITU data, this number is somewhere between the number of active mobile phone connections and the number of people who own one or more mobile phones.
- **InternetDensity.** The number of Internet subscribers with fixed access to the Internet divided by the de facto population, expressed as a percentage between 0 and 100. This measure includes dial-up, broadband, cable modem, DSL, and any other service provider. Mobile data subscriptions are not included in this measure.
- **PhoneDensity:** The number subscribers to wireline telephone service divided by the de facto population, expressed as a percentage between 0 and 100. Mobile and satellite telephone connections are not included in this measure.

A summary of the evolution of these three primary measures of digital access is provided in Figure 3.

⁵ Further details and a complete list of these questions for 2010 is available at http://www.freedomhouse.org/template.cfm?page=351&ana_page=362&year=2010

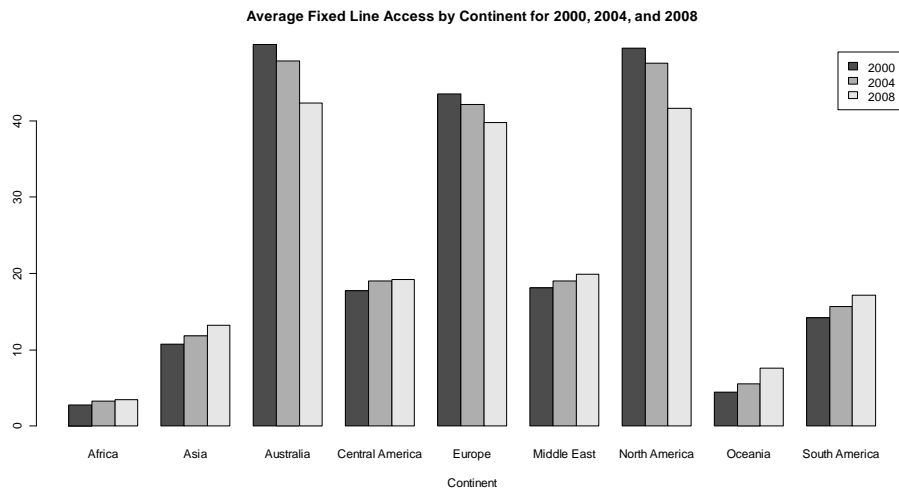
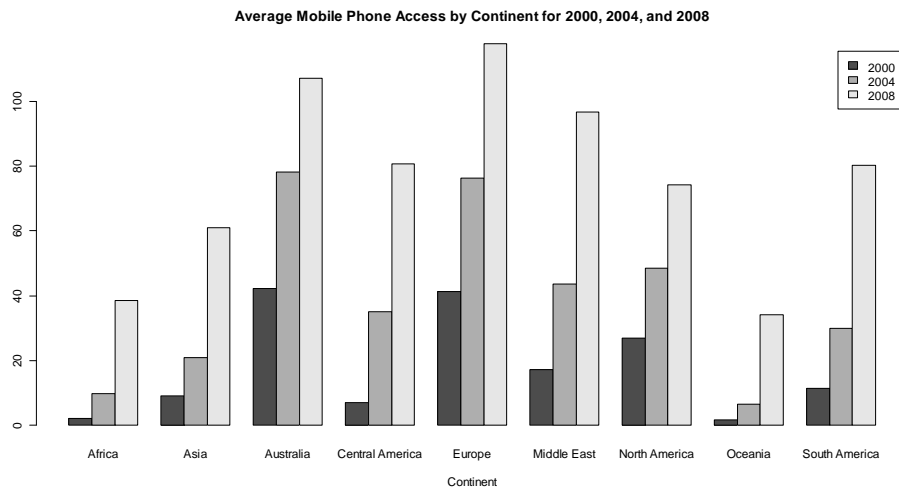
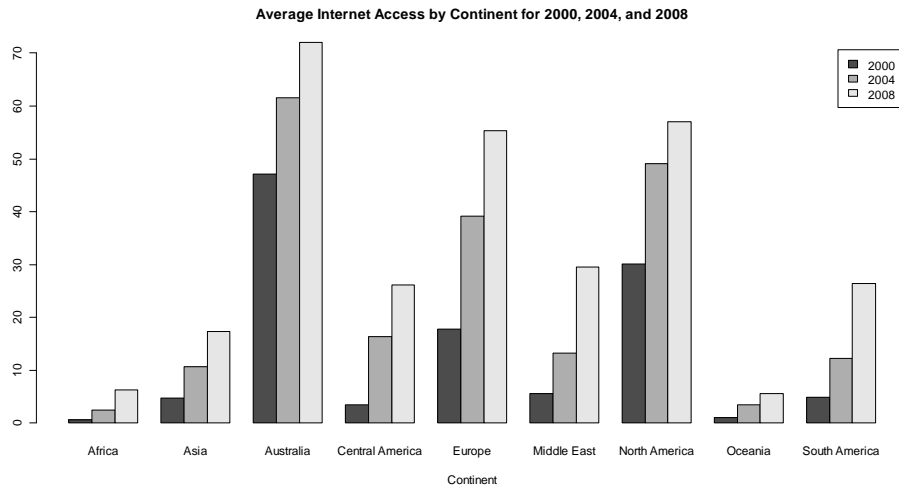


Figure 3: Three measures of digital access, 2000-2008.

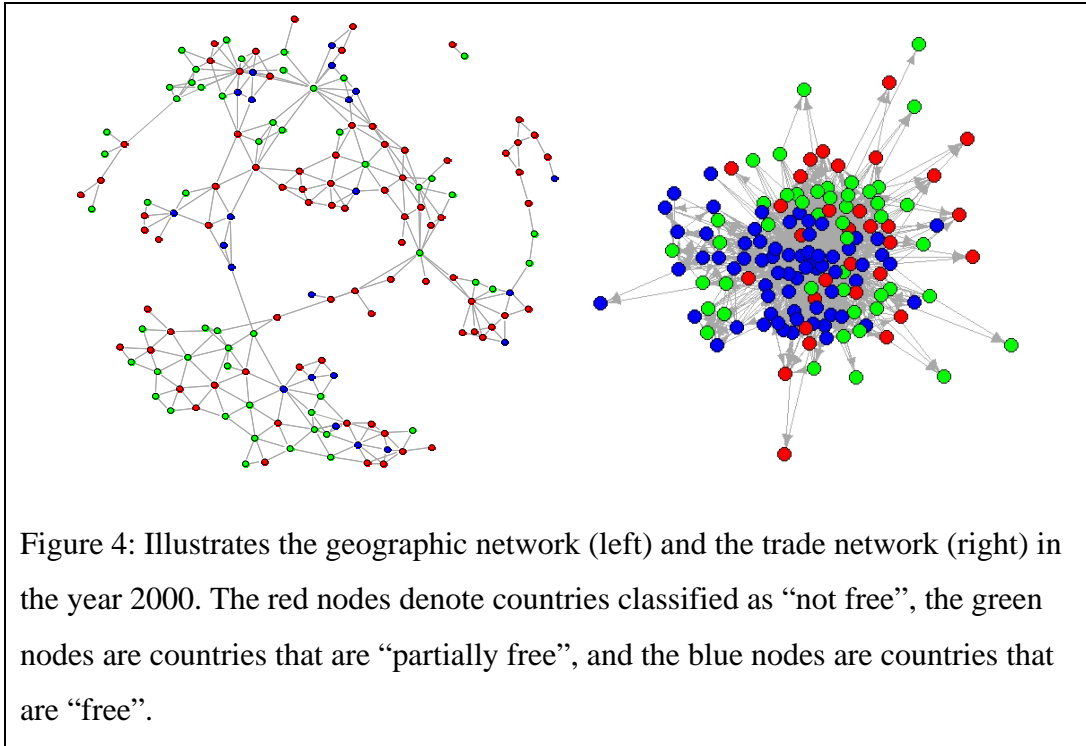
In some of the analysis that follows, we use the derived binary variables `InternetThreshold` and `MobileThreshold`. `InternetThreshold` takes the value 1 if the country's `InternetDensity` is larger than 50 (that is, if more than half the country's population has Internet access), and `MobileThreshold` takes the value 1 if the country's `MobileDensity` is above 75 (that is, if there are at least 75 mobile subscribers for each 100 people).

Network Variables. We construct the following networks for each year 2000-2008.

- **Geographic Network:** A graph in which each country is represented by a node, and a shared land border between two countries is represented as an edge between their corresponding nodes. We assembled and cross-checked inter-country political borders from a variety of sources, including the CIA World Factbook.
- **Trade Network:** A graph in which each country is represented by a node, and two nodes A and B are connected by a directed edge from A to B if Country A was one of the top exporters to Country B. Since different countries have different import volumes, we define country A as a top exporter to country B if A's level of export flows are at least 5% of the level of export flows of the country that exports the most to country B. Export and import dollar volumes are obtained using the commodities export flows data from the United Nations Comtrade database (<http://comtrade.un.org>).

The two networks for the year 2000 are illustrated in Figure 4.

For each network, we construct five different network variables for each country: `NeighborCivilLiberties`, `NeighborPoliticalRights`, `NeighborMediaFreedom`, `NeighborMobileDensity` and `NeighborInternetDensity`. For example, for the geographic network, `NeighborCivilLiberties` for country A is the average value of `CivilLiberties` for each country that shares a political border with country A. The other four variables are defined analogously.



Similarly, for the directed trade network, NeighborCivilLiberties for country A is the average value of CivilLiberties for all countries who are top exporters to country A (and whose nodes therefore have a directed edge in the trade network that terminates at the node corresponding to country A).

Control variables. We use a number of control variables that we believe might alternatively explain temporal and cross-country variations in the specific measures of digital access and democracy we have described above. These include measures of political structure as well as measures of economic development. Our two controls for political structure are:

- Checks: an approximate measure of the balance of power within a government. Checks is incremented by one for each chamber in the legislature and by one for every party active in the government which has an ideological center closer to the main opposition than to the executive’s party. For autocratic countries, Checks equals one. This variable was obtained from the World Bank’s Database on Political Institutions (<http://econ.worldbank.org>).

| Variable | 2000-2008 | | 2000 | | 2008 | |
|-------------------------|-----------|-------|---------|-------|---------|-------|
| | Average | SD | Average | SD | Average | SD |
| MobileDensity | 39.35 | 39.48 | 15.40 | 22.41 | 73.51 | 44.61 |
| InternetDensity | 16.43 | 21.51 | 7.26 | 12.24 | 26.14 | 25.87 |
| PhoneDensity | 18.43 | 18.84 | 18.24 | 20.18 | 18.43 | 17.47 |
| Checks | 2.84 | 1.61 | 2.85 | 1.53 | 2.94 | 1.85 |
| MaleLaborForce | 75.83 | 10.18 | 76.26 | 10.22 | 75.64 | 10.08 |
| LifeExpectancy | 67.23 | 10.60 | 66.26 | 10.53 | 68.30 | 10.44 |
| UrbanPopulationRatio | 54.20 | 23.20 | 52.92 | 23.50 | 55.53 | 22.99 |
| RuralPopulationRatio | 45.80 | 23.20 | 47.08 | 23.50 | 44.47 | 22.99 |
| TotalPopulation (log) | 15.90 | 1.75 | 15.84 | 1.76 | 15.96 | 1.76 |
| Population15 | 62.02 | 6.57 | 60.74 | 6.46 | 63.22 | 6.61 |
| PopulationGrowth | 1.47 | 1.29 | 1.50 | 1.36 | 1.48 | 1.34 |
| FixedBroadbandInternet | 2.93 | 6.76 | 0.18 | 0.82 | 6.99 | 11.01 |
| GDP | 8854 | 14295 | 6146 | 9462 | 13340 | 20040 |
| Geographic Network | | | | | | |
| NeighborCivilLiberties | 3.63 | 2.06 | 3.43 | 1.97 | 3.73 | 2.09 |
| NeighborPoliticalRights | 3.58 | 2.23 | 3.52 | 2.25 | 3.55 | 2.20 |
| NeighborMediaFreedom | 40.99 | 25.21 | 41.10 | 25.72 | 39.91 | 24.52 |
| NeighborMobileDensity | 31.77 | 33.76 | 11.68 | 17.09 | 61.65 | 41.35 |
| NeighborInternetDensity | 12.44 | 16.85 | 5.10 | 8.38 | 20.97 | 21.37 |
| NeighborGDP | 6610 | 10938 | 4561 | 7284 | 10070 | 15046 |
| Trade Network | | | | | | |
| NeighborCivilLiberties | 4.77 | 2.22 | 4.73 | 2.01 | 4.21 | 2.60 |
| NeighborPoliticalRights | 4.86 | 2.28 | 5.11 | 2.18 | 4.20 | 2.60 |
| NeighborMediaFreedom | 56.84 | 26.76 | 60.28 | 25.82 | 48.20 | 29.99 |
| NeighborMobileDensity | 55.63 | 32.43 | 35.09 | 17.28 | 73.38 | 45.51 |
| NeighborInternetDensity | 30.92 | 18.40 | 18.54 | 9.60 | 37.04 | 24.48 |
| NeighborGDP | 18200 | 10633 | 14880 | 7554 | 21250 | 14555 |

Table 1: Summary Statistics

- ElectoralDemocracy: A binary variable which is coded as 1 if the country had an electoral democracy as their government form for the corresponding year. This variable was obtained from Freedom House.

Each of our controls for economic development was obtained from the World Bank's World Development Indicators database (<http://econ.worldbank.org>).

They are:

- MaleLaborForce: The proportion males older than 15 in the population who provide labor during the year.
- LifeExpectancy: the number of years that a newborn infant is expected to survive if the mortality rates remain constant.

- **UrbanPopulationRatio**: the ratio of the population living in urban areas as classified by national statistical offices.
- **RuralPopulationRatio**: the ratio of the population living in rural areas as classified by national statistical offices.
- **TotalPopulation**: the mid-year estimate of the number of people residing in the country's borders, regardless of legal status or citizenship. This de facto population definition excludes refugees who have not permanently settled in their asylum country.
- **Population15-64**: the percentage of the total population between the ages of 15 and 64, irrespective of citizenship status.
- **PopulationGrowth**: the exponential rate of growth of midyear population from the previous year to the current year, expressed as a percentage
- **FixedBroadbandInternet**: the number of broadband subscribers with a digital subscriber line, cable modem, or other high-speed technology divided by the de-facto population

3. Digital Access, Democracy and Diffusion

Our initial analysis uses panel data methods (Woolridge, 2002) to provide an assessment of the relationship between democracy, digital access and our two networks of countries. We have chosen to use CivilLiberties as the dependent variable across the entire analysis of this section. This is based on our belief that civil liberties are likely to be affected more rapidly by changes in digital access than political rights which require more substantive structural changes in the way government is organized. (In the language of Faris and Etling 2008, civil liberties are altered more by changes in “vertical processes” that digital technologies have a more natural impact on, while changes in political rights depend more on corresponding changes in “horizontal processes”.) Our empirical design assesses the direct impact of digital access and neighbor characteristics on civil liberties; additionally, as discussed briefly in an earlier section, we include media freedom

as an independent variable since it is possible that the changes induced by digital access are mediated by changes in media freedom. We have estimated models that include PoliticalRights as a control variable and those which do not, with no directionally significant differences in any of the coefficient values. Retaining both these alternative measures of democracy in each of our specifications ensures that we are not incorrectly ascribing a change in civil liberties to a change in digital access when in fact the former may have been caused by a change in one of these other related measures of political structure or freedom.

We control for unobserved heterogeneity in our data by grouping the panel data by continent and by country (as indicated under “grouping” in Table 2). This grouping is based on our conjecture that there may be unobserved causes for the variation in democracy across continents, as well as admitting the possibility that the nature of the effects of digital access on civil liberties may vary across different regions of the world. Consequently, we report on estimates that use fixed effects, as well as those which use random effects and random coefficients to account for unobserved heterogeneity. More precisely, each of our mixed model specifications places a random coefficient on the Checks control variable, specifies a random intercept, and random effects that are grouped hierarchically by continent and then by country. Each of our fixed effects specifications groups the data by continent and by country. Further details on these methods and of our specific implementation of them are available in Woolridge (2002) and Pinheiro et al. (2011).

Table 2 summarizes the results of a subset of our panel data analysis. A number of interesting observations emerge from this analysis. As illustrated by the first two rows of Table 2, civil liberties are positively associated with both political rights and media freedom, and this relationship is significant for every model specification we have tried. More importantly, most of our model specifications find a positive relationship between changes in civil liberties and changes in each of our three measures of digital access: the density of Internet users, the density of mobile ‘phone users, and the density of traditional (wireline) phone users.

Dependent Variable is Civil Liberties

| Effects Grouping | Mixed Model | Fixed Effect | Mixed Model | Fixed Effects | Mixed Model | Fixed Effect | Mixed Model | Fixed Effect |
|--------------------------|-----------------------|------------------------|-----------------------|-----------------------|-----------------------|------------------------|---------------------------|------------------------|
| | Checks | Within | Checks | Within | Checks | Within | Checks | Within |
| | Continent/Country | Country | Continent/Country | Country | Continent/Country | Country | Continent/Country | Country |
| Political Rights | 0.3902 (0.0211)*** | 0.2829 (0.0224)*** | 0.3914 (0.0211)*** | 0.2856 (0.0225)*** | 0.3854 (0.0212)*** | 0.2876 (0.0224)*** | 0.3918 (0.0209)*** | 0.2884 (0.0225)*** |
| Media Freedom | 0.0162 (0.0016)*** | 0.0121 (0.0018)*** | 0.0161 (0.0016)*** | 0.0122 (0.0018)*** | 0.0164 (0.0016)*** | 0.0118 (0.0018)*** | 0.01667 (0.0016)*** | 0.0125 (0.0018)*** |
| Internet Density | 0.0072 (0.0027)*** | 0.0069 (0.0024)*** | 0.0048 (0.00248)* | 0.0047 (0.0024)* | 0.0065 (0.0028)** | 0.0054 (0.0025)** | 0.0055 (0.0027)** | 0.0064 (0.0024)*** |
| Internet Threshold | 0.6327 (0.2894)** | 1.0359 (0.2538)*** | -0.0458 (0.1042) | -0.0484 (0.1057) | 0.5888 (0.3126)* | 1.0870 (0.2822)*** | 0.6960 (0.3574)* | 0.9261 (0.3631)** |
| Mobile Density | 0.0025 (0.0010)** | -0.0010 (0.0010) | 0.0024 (0.0009)*** | 0.0010 (0.0009) | 0.0021 (0.0011)* | -0.0009 (0.0010) | 0.0012 (0.0011) | -0.0011 (0.0010) |
| Mobile Threshold | 0.1743 (0.1425) | -0.1939 (0.1190) | -0.0807 (0.0697) | -0.1019 (0.0640) | 0.0858 (0.1548) | -0.2888 (0.1344)** | 0.0383 (0.1779) | -0.2913 (0.1618)* |
| Phone Density | 0.0075 (0.0033)** | 0.0056 (0.0039) | 0.0093 (0.0032)** | 0.0087 (0.0038)** | 0.0089 (0.0034)*** | 0.0059 (0.0039) | 0.0101 (0.0033)*** | 0.0059 (0.0039) |
| Internet Threshold* | -0.0115 (0.0052)** | -0.0189 (0.0043)*** | N/A | N/A | -0.0110 (0.0053)** | -0.0190 (0.0044)*** | -0.0129 (0.0052)** | -0.0196 (0.0044)*** |
| Mobile Threshold * | -0.0020 (0.0018) | 0.0032 (0.0014)*** | N/A | N/A | -0.0017 (0.0018) | 0.0026 (0.0015)* | -0.0006 (0.0018) | 0.0034 (0.0015)** |
| Network | None | None | Geographic | Geographic | Geographic | Geographic | Trade | Trade |
| Internet Threshold* | N/A | N/A | 0.0106 (0.0185) | 0.0067 (0.0178) | 0.0024 (0.0196) | -0.0090 (0.0193) | 0.0031 (0.0437) | 0.0252 (0.0466) |
| NeighborCivilLiberties | N/A | N/A | 0.0254 (0.0146)* | 0.0456 (0.0131)*** | 0.0153 (0.0154) | 0.0397 (0.0146)*** | 0.0056 (0.0178) | 0.0159 (0.0189) |
| NeighborPoliticalRights | N/A | N/A | N/A | N/A | 0.1092 (0.0432)** | 0.0407 (0.0490) | 0.2592 (0.0549)*** | 0.1139 (0.0664)* |
| NeighborInternetDensity | N/A | N/A | N/A | N/A | -0.0091 (0.0377) | 0.0183 (0.0405) | -0.0669 (0.0566) | -0.0101 (0.0682) |
| NeighborMobileDensity | N/A | N/A | N/A | N/A | 0.0015 (0.0035) | 0.0006 (0.0031) | 0.0003 (0.0028) | -0.0019 (0.0034) |
| NeighborMediaFreedom | N/A | N/A | N/A | N/A | 0.0000 (0.0000) | 0.0000 (0.0000) | -0.0000002 (0.0000003) | 0.0000 (0.0000) |
| Development and Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 2: Panel data analysis results

Notice that this positive relationship between digital access and democracy is significant after accounting for the two related measures of democracy (political rights and media freedom), both political structure variables (electoral democracy and checks), and controlling for changes in all 8 of the measures of economic development discussed in Section 2 (GDP, labor participation, fraction of urban population and so on) that might be simultaneously causing changes in both digital access and civil liberties. We restrict our interpretation of these coefficients to their signs, while noting that their magnitudes are in a range that makes their impact noticeable. There is also some evidence that this effect is more pronounced for countries with a *lower* base level of Internet access density (based on the fact that the InternetThreshold variable interacted with the InternetDensity variable has a positive and significant coefficient); interestingly, we did not find evidence of a similar effect for mobile access density.

We also find that a country's level of civil liberties are positively related to the level of civil liberties of its neighbors, both in the trade network as well as in the geographic network. This evidence is consistent with a theory that civil liberties diffuse across connected countries. Additionally, we find no evidence that a country's civil liberties are associated with other measures of its neighbors' digital access or levels of democracy. Furthermore, interacting both our digital access *threshold* variables with the civil liberties network variables indicates that this diffusion effect may be more pronounced for countries that have a high level of *mobile* access. This is striking because it provides the first evidence that a form of digital access, one that is especially dominant and growing in the industrializing world, may amplify these spillovers in democracy across countries. While we see a similar (albeit smaller) positive amplification effect for traditional Internet access, it is not statistically significant. These empirical results are consistent with a theory that digital access makes a country's citizens more aware of changes in the countries that they are politically and economically connected to, and perhaps this awareness translates to activities by these citizens that make the diffusion of these changes more likely. An alternative explanation is that higher levels of digital access induce a change in citizens (for example, a greater

level of “networked individualism”, or a greater ability to coordinate actions) which in turn may lead to a greater propensity to react to changes they become aware of via non-digital information channels.

There is a possibility that it may take a few years of sustained high levels of digital access before one observes changes in civil liberties, which would suggest the possibility that digital access has a lagged effect of on civil liberties. We explored this possibility empirically by estimating and analyzing a number of dynamic panel models. The results are quite sensitive to the lag structure we impose, and these dynamic panel models are perhaps not best suited for longitudinal network data in which the network changes over time. Consequently, we instead adopt a more structured dynamic network analysis which we describe in our following section.

4. The Co-Evolution of Democracy, Trade Networks and Digital Access

While our results thus far suggest a persistent relationship between digital access and democracy, as well as suggesting the possibility that there are spillovers in democracy across connected countries that are amplified by digital access, there may be possible alternative explanations for our findings. For example, rather than being induced by changes in digital access, higher levels of civil liberties may cause individuals to seek greater digital access. It is also possible that countries simply form trade ties with higher export and import flows with others whose civil liberties are similar to theirs, for example, in response to their citizens not wanting to trade with countries with poor human rights records. Thus, changes in civil liberties may cause change in trade ties, rather than the ties inducing a diffusion of the changes in liberties.

It is well documented that when considering changes in behaviors across networked individuals, one should consider the possibility of the co-evolution of these individuals and their networks: changes in the network may cause changes in behaviors, which in turn may induce further changes in individual behavior

(Lazer, 2001). A similar dynamic is possible with countries and their levels of democracy: information flows via trade networks may induce changes in political rights or civil liberties, and these changes may in turn cause a reconfiguration of the network of trading partners. It could also be that nodes with similar levels of democracy choose to form ties with each other. Put differently, the trade network of countries may display assortative mixing in democracy levels due to “homophily”, selection or actual influence-based diffusion.

There are a number of possible approaches that can partially identify and distinguish between these different effects from our longitudinal data sets of networks and behaviors. We have chosen to base our dynamic empirical analysis on the stochastic actor-oriented model of Snijders et al. (2010). While we considered using the matched sample framework of Aral et al. (2009), it is better suited for larger networks where node homophily rather than new tie formation is the alternative explanation for influence-based diffusion. In contrast, the SIENA framework lends itself more naturally to our setting of continuous co-evolution of network ties and node “behaviors” in a relatively small network.

The model underlying SIENA decomposes the evolution of the system into two related processes that unfold in parallel over time: the evolution of the trade network and the evolution of associated “behaviors” and “covariates”: digital access, democracy and the political/economic development controls. It is assumed that the “behaviors” (which are our variables of interest) and the network may change at any instant in continuous time, although we, the researchers, only observe the state of the network at discrete time intervals; the remaining “covariates” change only at those time instants that the network is observed. There is a rate associated with each behavior and with the network in each time period (between each observation), which captures the overall propensity of changes in the network/behavior during that period.

For computational reasons, we estimate this model using data from three (rather than all nine) time periods: 2000, 2004 and 2008, and we restrict our attention to the evolution of three behaviors: Political Rights, Civil Liberties and Media

Freedom. Furthermore, in the model whose estimation we report on, we use the following covariates: Mobile Threshold, Internet Threshold (our two primary digital access variables), GDP (included as the most important control variable) and Phone Density (included since it consistently had a positive relationship with each of the measures of democracy in the panel data analyses).

During the period 2000-2004 (or alternatively, 2004-2008), each node A of the trade network is modeled as evolving a function of three network characteristics:

- OutDegree, the number of existing countries to which country A is a top exporter, which reflects an expectation that forming new trade ties is inherently costly and there is a limit on the number of countries to which one can export sufficiently high volumes to be a top exporter.
- Reciprocity, whether each potential neighbor is a top exporter to country A, which reflects an expectation that on average, high volume trade ties tend to be reciprocal.
- Transitive triplets, which admits the possibility that if A is a top exporter to B and B is a top exporter to C, this could affect the propensity of A to be a top exporter to C.

In addition, the network is modeled as evolving as a function of each of the three behaviors (the measures of democracy), the two primary measures of digital access, and GDP. The three kinds of effects that these node characteristics are specified as possibly having on trade tie formation are **ego** (the level of democracy or digital access can affect the propensity of a country to form top exporter ties), **alter** (the level of democracy or digital access can affect the propensity of a country to be the recipient of exports), and **similarity** (a country may have a higher propensity to form export ties with other countries which have a similar level of democracy or comparable levels of digital access).

Table 3(a): The co-evolution of digital access, trading ties and democracy

| Network Formation | | | |
|---------------------------------|-----------------|-----------------------|----------------|
| <u>Variable</u> | <u>Estimate</u> | <u>Standard Error</u> | <u>T-ratio</u> |
| Rate period 1 | 6.6637 | 0.3271 | 20.37 |
| Rate period 2 | 8.4256 | 0.3926 | 21.46 |
| Outdegree | -2.7125 | 0.0559 | -48.52 |
| Reciprocity | 0.7249 | 0.089 | 8.14 |
| Transitive triplets | 0.1622 | 0.0061 | 26.59 |
| Political Rights alter | 0.0939 | 0.0703 | 1.34 |
| Political Rights ego | -0.0413 | 0.0619 | -0.67 |
| Political Rights similarity | 0.0898 | 0.3571 | 0.25 |
| Civil Liberties alter | -0.0884 | 0.0975 | -0.91 |
| Civil Liberties ego | 0.162 | 0.0983 | 1.65 |
| Civil Liberties similarity | -0.4125 | 0.4934 | -0.84 |
| Media Freedom alter | -0.0122 | 0.0043 | -2.84 |
| Media Freedom ego | -0.0036 | 0.0046 | -0.78 |
| Media Freedom similarity | 0.9026 | 0.3605 | 2.50 |
| Internet Threshold alter | 0.0374 | 0.1458 | 0.26 |
| Internet Threshold ego | 0.1628 | 0.1638 | 0.99 |
| Internet Threshold similarity | 0.1692 | 0.1341 | 1.26 |
| GDP alter | 0 | 31.607 | 0.00 |
| GDP ego | 0 | 31.607 | 0.00 |
| GDP similarity | 0.5359 | 0.3183 | 1.68 |
| Mobile Threshold alter | -0.3657 | 0.136 | -2.69 |
| MobileThreshold ego | -0.5578 | 0.1299 | -4.29 |
| Mobile Threshold similarity | -0.1699 | 0.0988 | -1.72 |
| Political Rights | | | |
| <u>Variable</u> | <u>Estimate</u> | <u>Standard Error</u> | <u>T-Ratio</u> |
| Rate period 1 | 1.2054 | 0.2983 | 4.04 |
| Rate period 2 | 0.6652 | 0.2355 | 2.82 |
| Linear | 0.3472 | 0.243 | 1.43 |
| Quadratic | -0.5688 | 0.328 | -1.73 |
| Effect from Civil Liberties | 1.699 | 0.9803 | 1.73 |
| Effect from Internet | -4.8645 | 5.6043 | -0.87 |
| Threshold | | | |
| Effect from Mobile Threshold | -0.1036 | 2.7581 | -0.04 |
| Effect from Phone Density | 0.0197 | 0.0209 | 0.94 |

Table 3(b): The co-evolution of digital access, trading ties and democracy, contd.

| Civil Liberties | | | |
|---------------------------------------|-----------------|-----------------------|----------------|
| <u>Variable</u> | <u>Estimate</u> | <u>Standard Error</u> | <u>T-Ratio</u> |
| Rate period 1 | 1.2021 | 0.2353 | 5.11 |
| Rate period 2 | 0.6294 | 0.1701 | 3.70 |
| Linear | 1.4247 | 0.4069 | 3.50 |
| Quadratic | -1.3226 | 0.408 | -3.24 |
| Effect from Political Rights | 1.0516 | 0.5345 | 1.97 |
| Effect from Media Freedom | 0.0769 | 0.0329 | 2.34 |
| Effect from Internet Threshold | -8.1274 | 3.0202 | -2.69 |
| Effect from Mobile Threshold | 8.3045 | 3.9009 | 2.13 |
| Effect from Phone Density | 0.0521 | 0.0276 | 1.89 |
| Media Freedom | | | |
| <u>Variable</u> | <u>Estimate</u> | <u>Standard Error</u> | <u>T-Ratio</u> |
| Rate period 1 | 96.389 | 11.7697 | 8.19 |
| Rate period 2 | 20.3411 | 2.968 | 6.85 |
| Linear | -0.0669 | 0.0194 | -3.45 |
| Quadratic | -0.0033 | 0.001 | -3.30 |
| Effect from Civil Liberties | 0.1066 | 0.0316 | 3.37 |
| Effect from Internet Threshold | -0.9476 | 0.3559 | -2.66 |
| Effect from Mobile Threshold | -0.0897 | 0.102 | -0.88 |
| Effect from Phone Density | 0 | 0.0008 | 0.00 |

Correspondingly, the levels of democracy of a country are modeled as evolving as follows: based on a basic level effect (which captures the overall preference for each measure of democracy), a quadratic effect (which captures the possibility that the current level of democracy may affect the future level of democracy), effects from other measures of democracy (which captures the possibility that, for example, the current level of media freedom might affect the future level of civil liberties), and effects from the levels of digital access (for example, a higher level of mobile access may cause an increase in the level of civil liberties).

The results of this analysis are summarized in Tables 3(a) and 3(b). (Further discussion of the underlying model is available in Snijders et al., 2010.) As anticipated, countries with a large number of top-export relationships have a lower propensity to form ties (the Outdegree coefficient is negative and

significant), countries have a higher propensity to form export ties with those they import a lot from (the Reciprocity coefficient is positive and significant), and trade ties tend to be clustered. Interestingly, we uncover very little evidence of selection based on civil liberties or political rights (neither the alter nor ego coefficients are significant), or of tie formation based on similarity on level of civil liberties or political rights. Further, as illustrated by the coefficients in Table 3(b), there was a positive increasing tendency for civil liberties (positive Linear coefficient) which diminished with an increase in the base level (negative Quadratic coefficient). There was also a negative tendency for media freedom, reflecting global decrease in this measure over the last decade.

The most interesting findings from the dynamic analysis were those that strengthened and altered the documented relationship between digital access and civil liberties. Specifically, mobile access has a strong positive effect on civil liberties in the 2000-2008 time period, even after accounting for all the other selection and reverse causation effects we have controlled for. This is consistent with a conjecture that mobile access improves a citizenry's ability to exchange information and coordinate activities in a manner that results in greater levels of liberty. In a sense, mobile technology plays a greater role in facilitating coordination of the kind described by Michael Chwe (2003), which, rather than transmitting new information about a government and its functioning, or creating greater parliamentary/ideological transparency, simply facilitates the "common knowledge" that is necessary to counter pluralistic ignorance and lead to collective action.

Strikingly, "traditional" wireline Internet density has a corresponding negative effect on both political rights. A possible explanation for this finding is that after accounting for other effects, the net effect of a sufficiently high increase in traditional Internet access (one that causes the country to cross the 50% density threshold) is one of increased control rather than increased freedom; this is consistent with the possibility that as the Internet becomes the dominant channel of information access, the ability of a government to leverage this technology to

mediate information transparency grows. Perhaps the countries that have recently crossed this threshold in the last decade are those which were especially susceptible to this form of control.

There are many possible explanations for the negative coefficients of Mobile Threshold alter and ego. Intuitively, their values suggest that countries which have crossed over to a high density of mobile access between 2000-2008 have also lost trade ties, which may simply reflect the fact that the countries which have crossed this threshold between 2004 and 2008 were fairly different in their trade profiles to those that were above the threshold prior to 2004.

Concluding Remarks

We have examined the effects of digital access on the prevalence of democracy and its diffusion via trade/geographical networks across 152 countries between 2000 and 2008. Our panel data analysis uncovers a consistent positive relationship between civil liberties and digital access, and suggests that mobile access may also increase the extent to which a country to democratic changes in neighboring nations. Investigation of this relationship further using a dynamic actor-oriented model of the co-evolution of digital access, measures of democracy and trade tie formation suggests that mobile access has a stronger positive intra-country effect on civil liberties than Internet access, which may in fact have a negative effect on democracy. Our analysis is based on a publicly available data and uses state-of-the-art empirical econometric and network analysis methods. To our knowledge, our work represents the first attempt to simultaneously examine changes in digital access and the evolution of different measures of democracy while admitting the possibility of inter-country spillovers and trade partner selection effects.

While trade flows and geography appear to be the best available proxies at this time, it would be useful for future studies to have richer data about the inter-country linkages that capture the diffusion of information and ideology more

precisely. Also, while we control for a number of country-specific factors, studies like ours would benefit from variables that capture variation in socio-political structure and history. As Haykel (2011) points out, these may be important determinants of the susceptibility of a country to the regional diffusion of democratizing revolutions.

We have entered an era in which new generations of socially and economically important technologies like mobile computing devices, social media and location-based software get created for and refined by consumers rather than by large enterprises, a trend often referred to as the consumerization of information technologies (Bapna et al., 2011). This contrasts the “business first” historical pattern of evolution of hardware (from mainframes to minicomputers to PCs) and software (from accounting information systems to enterprise resource planning systems and spreadsheets) and their associated transformative impacts on business (Dhar and Sundararajan, 2007). The consumerization of IT is not just about a change in the target market for new technologies; it represents a fundamental paradigm shift which gives distributed people new capabilities for human endeavor and freedom, and may lead to information technologies fulfilling their true potential for societal and national transformation. The dominance of the democratizing effects of mobile access over traditional Internet access is especially encouraging in this regard, given that this is the device that is at the forefront of the consumerization of IT, and which will be the conduit for digital access for a vast majority of new Internet users over the coming decades.

The impact of digital access on freedom and its diffusion is still in its infancy. The longer-run effect of having a technologically connected world on basic civil liberties and political rights will unfold over the coming decades. Our analysis provides a first empirical step towards uncovering what this impact might look like. We look forward to participating in and analyzing the continued democratizing effects of information and communications technologies.

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