NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

POLITICAL REVOLUTION AND SOCIAL COMMUNICATION TECHNOLOGIES

by

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December 2017

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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE December 2017	3. REPORT TYPE AND DATES COVERED Master's thesis

4. TITLE AND SUBTITLE POLITICAL REVOLUTION AND SOCIAL COMMUNICATION TECHNOLOGIES	5. FUNDING NUMBERS
6. AUTHOR(S) Matthew P. Kent and Yong J. Lee	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB number ____N/A____.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

The relatively recent advent of cell phones provides an increasing portion of the world's population with hitherto unprecedented access to information, and offers a novel means of networking and communicating within and across societies. Since cell phones have been utilized in collective action events such as the Arab Spring, this thesis seeks to determine their role, if any, in events that lead to political revolution. Using non-linear logistic regression techniques, this study assesses the relationship between cell phone use and political revolutions, both democratic and autocratic, from 1980 to 2015. The results of the study indicate that there is a strong negative relationship between cell phone use and democratic political revolution, suggesting that higher levels of cell phone use actually reduce the probability of democratic political revolution, and may bolster existing autocracies. We speculate that this may result from governments' ability to use cell phones and social communication technologies for population control and suppression; furthermore, the horizontal and decentralized nature of communications enabled by cell phones may create amorphous organizations that have difficulty effecting government change.

14. SUBJECT TERMS political revolution, cell phone, non-linear logistic regression, authoritarian, autocratic, democratic, civil conflict, collective action, mass media, social media, information and communications technologies (ICT), horizontal and decentralized	15. NUMBER OF PAGES 67
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89) Prescribed by ANSI Std. 239-18

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POLITICAL REVOLUTION AND SOCIAL COMMUNICATION TECHNOLOGIES

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MASTER OF SCIENCE IN INFORMATION STRATEGY AND POLITICAL WARFARE

from the

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ABSTRACT

The relatively recent advent of cell phones provides an increasing portion of the world's population with hitherto unprecedented access to information, and offers a novel means of networking and communicating within and across societies. Since cell phones have been utilized in collective action events such as the Arab Spring, this thesis seeks to determine their role, if any, in events that lead to political revolution. Using non-linear logistic regression techniques, this study assesses the relationship between cell phone use and political revolutions, both democratic and autocratic, from 1980 to 2015. The results of the study indicate that there is a strong negative relationship between cell phone use and democratic political revolution, suggesting that higher levels of cell phone use actually reduce the probability of democratic political revolution, and may bolster existing autocracies. We speculate that this may result from governments' ability to use cell phones and social communication technologies for population control and suppression; furthermore, the horizontal and decentralized nature of communications enabled by cell phones may create amorphous organizations that have difficulty effecting government change.

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LIST OF ACRONYMS AND ABBREVIATIONS

AIC	Akaike Information Criterion
AUC	Area Under the Curve (statistic)
CSP	Center for Systemic Peace
GDP	Gross Domestic Product
ICT	Information and Communications Technologies
MDI	Media Density Index
ROC	Receiver Operating Characteristic
WDI	World Development Indicators

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ACKNOWLEDGMENTS

We would like to thank the Army and the FA30 branch (Information Operations) for the opportunity to attend the Naval Postgraduate School. We would like to give special thanks to our thesis advisor, Professor T. Camber Warren, and our second reader, Professor Robert Weiner, for their tremendous academic support and assistance. We would like to express our gratitude to the entire Defense Analysis Department for the wonderful experience and learning environment. We would also like to thank Lieutenant General Kenneth Tovo and the United States Army Special Operations Command (USASOC) for their support and for linking us to a variety of organizations and subject-matter experts. We would like to also thank our families, colleagues, friends, and professors who supported us during our time at the Naval Postgraduate School.

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I. INTRODUCTION

Recent advances in the variety, availability and affordability of social communication technologies, such as cell phones, provide new methods for accessing and sharing information and ideas within and across societies and provide novel conduits for communicating with various audiences around the globe, to include audiences in previously closed authoritarian environments. With the ability to access the internet and conduct two-way communications, cell phones allow users to transcend traditional cultural, social, political and geographic boundaries at near-instantaneous speeds, which may provide the potential for more effective organized government opposition, or alternatively, may provide governments with additional tools for monitoring populations, suppressing dissent or propagating narratives. Using multivariate statistical models, this thesis seeks to answer the following question: *What role do cell phones play in events that lead to political revolution?*

Social communication technologies differ from the mass media technologies of television, radio and newspaper in several key ways. Social communication technologies are characterized by many-to-many, decentralized two-way communications, horizontal connections, and include, but are not limited to, social networking sites, text messaging and email.[1] Social communication technologies tend to form along socially segregated lines, and enable many potential senders or broadcasters. Mass media technologies consist of centralized, one way, vertical communications, with a small number of broadcasters.[2]

We chose to focus on cell phones because well documented statistics concerning global cell phone subscriptions are widely available. Cell phones allow a large portion of the global population to participate in the modern information space and serve as the ideal indicator of access to social communication technologies. Therefore, this thesis will

[1] T. Camber Warren, "Explosive Connections? Mass Media, Social Media, and the Geography of Collective Violence in African States," *Journal of Peace Research* 52, no. 3 (2015): 308.

[2] T. Camber Warren, "Not by the Sword Alone: Soft Power, Mass Media, and the Production of State Sovereignty," *International Organization* 68, no. 1 (2014): 15.

use cell phone ownership rates as a means to measure countries' use of cell phones and level of access to social communication technologies.

The quantitative analysis in this thesis finds that there is a strong negative relationship between cell phone use and democratic political revolutions, suggesting that higher levels of cell use actually reduce the likelihood of democratic political revolution, and may bolster already existing autocracies. While many scholars cite the role that social communication technologies played in the collective action events of the 2010 to 2011 Arab Spring, as this thesis will highlight, these events did not always result in political revolution.[3] Although Egypt, Tunisia, Libya, Yemen, Syria, and Bahrain all experienced uprisings during the Arab Spring, only Tunisia experienced a successful democratic political revolution following these collective action events. Additionally, we find that there is a strong positive relationship between mass media and democratic political revolution, suggesting that higher levels of mass media actually increase the likelihood of democratic political revolution. Our statistical analysis yielded another surprising finding: by far the most predictive indicator of political revolution among the variables we examined was a country's level of polity.[4] Chapter III will explain in detail the concept of polity, or government type, which is a key aspect of this study.

[3] Philip N. Howard and Muzammil M. Hussain, "What Best Explains Successful Protest Cascades? ICTs and the Fuzzy Causes of the Arab Spring," *International Studies Review* 15 (2013): 64.

[4] The level of polity is determined using the internationally recognized government type scale developed by the Center for Systemic Peace 21-point Polity IV data set. "Center for Systemic Peace," The Polity Project, accessed June 09, 2017, http://www.systemicpeace.org/polityproject.html.

II. LITERATURE REVIEW AND HYPOTHESES

A. CELL PHONES

The increased availability and affordability of information, communications and media-viewing technologies provide the potential for a rising flow of information across the globe, to include previously closed or isolated societies. Cell phones provide users with a variety of functions, including the ability to access an array of internet sites and social media applications, communicate via text messages, or check news or market conditions. The horizontal nature of communications facilitated by cell phones, with many senders and recipients, creates an environment where virtually anyone can actively participate in this information community. Some scholars argue that cell phones play an important role in democracy by extending the public domain, increasing access to information, and reducing the role of gatekeepers.[5] Cell phones and social communication technologies may provide a novel and effective means for organizing opposition against existing governments, though some studies conclude that the internet, which is increasingly accessed through cell phones, has not contributed to a global shift towards democracy,[6] while others argue that these technologies serve to strengthen the position of governments.[7]

The affordability and availability of cell phones may enable various elements with diverse levels of resources to organize widespread government opposition or support across vast geographic areas in extremely short time frames at relatively low cost. Pierskalla and Hollenbach state, "[c]ell phones as a communication technology allows political groups to overcome collective action problems more easily and improve in-

[5] Heike Hermanns, "Mobile Democracy: Mobile Phones as Democratic Tools," *Politics* 28, no. 2 (2008): 76.

[6] Espen Geelmuyden Rod and Nils B. Weidmann, "Empowering Activists or Autocrats? The Internet in Authoritarian Regimes," *Journal of Peace Research* 52, no. 3 (2015): 338.

[7] Colin D. Bylsma and Samuel T. Colby, "New Challenges to Authoritarian State Stability: The Proliferation of Modern Information Communications Technology," master's thesis, Naval Postgraduate School, Monterey, California, 2015.

group cooperation, and coordination."[8] Their study concludes that "cell phone coverage significantly and substantially increases the probability of violent conflict."[9] It is widely believed that these new social communications technologies may have played a role in the 2010 to 2011 Arab Spring uprisings by providing "ways to overcome restrictions on the freedoms of expression and association."[10] However, the ability to facilitate collective action does not always result in effective change in government type. As witnessed in Libya, over six years after the Arab Spring, the country remains in a state of transition without an effective government of any type.

Cell phones provide the general population and the government with the ability to "live stream" or obtain video or photographic evidence of events, which can be shared with audiences around the world almost immediately. Cell phones provide increased access to information and improved levels of knowledge for all parties that possess or have access to these instruments and networks. Images and videos of police brutality and videos of civilians harmed by war have the ability to stir emotions and create widespread awareness. These images, which may lead to action from the international community or demands to reform domestic policy, are often captured by witnesses using cell phones.

Others argue that the ability of government to control and monitor much of the network and communications infrastructure upon which cell phones rely actually strengthens the stability of governments.[11] These social networking technologies may also provide governments with a "repression technology" by creating additional venues for monitoring populations, conducting propaganda and organizing pro-government support.[12] A study conducted by Weidmann and Shapiro found that during periods of

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[8] Jan H. Pierskalla and Florian M. Hollenbach, "Technology and Collective Action: The Effect of Cell Phone Coverage on Political Violence in Africa," *American Political Science Review* 107, no. 2 (2013): 207.

[9] Jan H. Pierskalla and Florian M. Hollenbach, "Technology and Collective Action: The Effect of Cell Phone Coverage on Political Violence in Africa," *American Political Science Review* 107, no. 2 (2013): 207.

[10] Craig McGarty et al., "New Technologies, New Identities, and the Growth of Mass Opposition in the Arab Spring," *Political Psychology* 35, no. 6 (2014): 725.

[11] Espen Geelmuyden Rod and Nils B. Weidmann, "Empowering Activists or Autocrats? The Internet in Authoritarian Regimes," *Journal of Peace Research* 52, no. 3 (2015): 338.

[12] Geelmuyden, "Empowering Activists or Autocrats?," 338.

insurgency in Iraq, increased cell phone communications reduced levels of insurgent violence.[13] This finding supports an argument that cell phones make it easier and less costly for noncombatants to communicate and cooperate with the government and other anti-insurgent forces.[14] Bylsma and Colby found that the spread of communications and organizational media in authoritarian governments actually empowers regimes. The authors conclude that higher levels of social communication technologies contribute to less violence in authoritarian regimes.[15] During uprisings in Burma in 2007 and Iran in 2009, both of which were suppressed by authorities, activists were able share their experiences by posting videos and photographs to the internet.[16] However, the authorities later used these same videos and photographs to identify individuals for arrest.[17] A study examining the ability of the Syrian regime of Bashar al-Assad to create network outages indicates that "such network blackouts constitute a part of the military's strategy to target and weaken opposition groups."[18] While the capability to share experiences and expose potential human rights abuses may help hold all parties accountable for their actions, this information can also prove invaluable to those wishing to monitor the activities of others.

Some scholars cite the role cell phones may perform in economic development. Economist Jeffrey Sachs states that "[t]he cell phone is the single most transformative technology for development."[19] Waverman, Meschi and Fuss conclude, "A developing

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[13] Jacob N. Shapiro and Nils B. Weidmann,"Is the Phone Mightier than the Sword? Cellphones and Insurgent Violence in Iraq," *International Organization* 69, no. 2 (2015): 247.

[14] Shapiro, "Is the Phone Mightier than the Sword?," 247.

[15] Colin D. Bylsma and Samuel T. Colby, "New Challenges to Authoritarian State Stability: The Proliferation of Modern Information Communications Technology," master's thesis, Naval Postgraduate School, Monterey, California, 2015.

[16] Sam Gregory, "Cameras Everywhere: Ubiquitous Video Documentation of Human Rights, New Forms of Video Advocacy, and Considerations of Safety, Security, Dignity and Consent," *Journal of Human Rights Practice* 2, no. 2 (2010): 192.

[17] Gregory, "Cameras Everywhere," 192.

[18] Anita R. Gohdes, "Pulling the Plug: Network Disruption and Violence in Civil Conflict," *Journal of Peace Research* 52, no. 3 (2015): 352.

[19] "Upwardly Mobile in Africa: How basic cell phones are sparking economic hope and growth in emerging and even non-emerging nations," Bloomberg.com, last modified September 23, 2007, https://www.bloomberg.com/news/articles/2007-09-23/upwardly-mobile-in-africa/.

country which had an average of 10 more mobile phones per 100 population between 1996 and 2003 would have enjoyed per capita GDP growth that was 0.59 percent higher than an otherwise identical country."[20] Other studies find that the rising availability and affordability of cell phones and the reduced communication and interaction costs that cell phones provide help to improve market efficiency and individual productivity and may lead to a rise in per capita Gross Domestic Product (GDP).[21] Cell phones may improve the economic conditions for millions of people around the globe by improving access to markets, banking and other social and economic opportunities, which may increase the opportunity cost of revolution and ultimately play a pacifying role among populations.

As the number of cell phone users around the globe continues to increase, the utility of this tool will likely continue to broaden and become more entrenched in the lives of individuals around the globe. A 2016 Pew Research Center survey that focused on cell phone and smartphone use concluded that "a global median of 43% say that they own a cellphone that is a smartphone, which is defined as a cellphone that can access the internet and apps, such as an iPhone or an Android. An additional 45% across the 40 countries say they have a cellphone that is not a smartphone. A median of only 12% among respondents say that they do not own a cellphone of any kind."[22] While smartphones significantly aid the process of accessing social media applications such as Twitter or Facebook, any type of cell phone can perform basic texting and can even compose and read "tweets" on Twitter.[23]

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[20] Leonard Waverman, Meloria Meschi, and Melvyn Fuss, "The Impact of Telecoms on Economic Growth in Developing Countries," in, "Africa: the Impact of Mobile Phones," *The Vodafone Policy Paper Series*, no. 2 (2005): 2.

[21] Reuben Abraham, "Mobile Phones and Economic Development: Evidence from the Fishing Industry in India," *Information Technologies and International Development* 4, no. 1 (2007): 6.; Jenny C. Aker, "Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger," *American Economic Journal: Applied Economics* 2, (2010): 48.; Jenny C. Aker and Isaac M. Mbiti, "Mobile Phones and Economic Development in Africa," *Journal of Economic Perspectives* 24, no. 3 (2010): 208.

[22] Jacob Poushter, "Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies," Pew Research Center, February 22, 2016, http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/.

[23] Zachary Steinert-Threlkeld, "Spontaneous Collective Action: Peripheral Mobilization During the Arab Spring," *American Political Science Review* 111, no. 2 (2017): 384.

In the future, the ability of cell phones to facilitate collective action may play a greater role in events leading to political revolution. In accordance with those advocating the significant role that cell phones play in political revolution, we offer the following hypotheses:

H1: Higher levels of cell phone density increase the probability of political revolution.

B. MASS MEDIA

In contrast to communications via cell phones, mass media provide a small number of broadcasters or senders the ability to disseminate one-way, top-down messages to a large number of recipients. The mass media assets of television, newspaper and radio, historically the domain of government, may serve as valuable pacifying and unifying tools by providing governments with the ability to message large audiences with a single, coherent message.[24] Based on a 2014 study, Warren concludes, "densely constituted mass media systems dramatically reduce the probability of large-scale civil violence."[25] Mass media may also serve as a pacifying agent by providing the population with entertainment. A study by Kern and Hainmueller found that East Germans who watched West German television broadcasts primarily as a source of entertainment "were more satisfied with life in East Germany and more supportive of the East German regime."[26]

Other studies argue that mass media can promote violence, protests and discontent. Joseph Nye argues that the fall of communism in East Germany was due in large part to the "soft power" approach of the United States, which projected American culture, values, appeals and attraction to influence and shape the preferences of others.[27]

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[24] T. Camber Warren, "Explosive Connections? Mass Media, Social Media, and the Geography of Collective Violence in African States," *Journal of Peace Research* 52, no. 3 (2015): 308.

[25] T. Camber Warren, "Not by the Sword Alone: Soft Power, Mass Media, and the Production of State Sovereignty," *International Organization* 68, no. 1 (2014): 111.

[26] Holger Lutz Kern and Jens Hainmueller, "Opium for the Masses: How Foreign Media can Stabilize Authoritarian Regimes," *Political Analysis* 17, no. 4 (2009): 377.

[27] Joseph S. Nye, *Soft Power: The Means to Success in World Politics* (New York: Public Affairs, 2005): 5.

Another study found that during the Rwandan Genocide, mass media that encouraged ethnic violence significantly increased participation in killings by both civilians and militia.[28] An analysis on the impact of cross-border radio transmissions in Croatia found that after over 10 years of peace, nationalistic Serbian radio broadcasts received in Croatia triggered anti-Serbian ethnic sentiment among Croats.[29]

The effects of mass media can also be mixed. The impact of mass media is influenced by on a number of factors, to include the receptivity of the audience to the content of the broadcasts. A study focused on the role of radio in Germany during the interwar period in the 1920s and 1930s found that prior to the Nazi party's rise to power, Weimar pro-government radio broadcasts helped to slow the escalation of Nazi popularity.[30] However, in the following years, pro-Nazi radio transmissions served to increase party membership and provoke anti-Semitic activities and sentiment.[31] An interesting finding concerning the role of radio in Germany during this period concluded that anti-Semitic radio broadcasts served to reinforce or exacerbate preexisting dispositions, meaning the result was positive in areas with traditionally high levels of anti-Semitism and negative in areas with traditionally low levels of anti-Semitism.[32]

The source and content of information and messages are also important factors in the role of mass media in political revolution. Countries with high levels of press freedom allow for a certain level of discourse, which may permit various parties to utilize mass media to spread disparate narratives or rally support for their pro or anti-government cause. Countries that do not have the ability or desire to prevent mass media transmissions from opposition or foreign sources may also experience destabilizing

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[28] David Yanagizawa-Drott, "Propaganda and Conflict: Evidence from the Rwandan Genocide," *The Quarterly Journal of Economics* 129, no. 4 (2014): 1947.

[29] Stefano Della Vigna, Ruben Enikolopov, Vera Mironova, Maria Petrova, et al.,"Cross-Border Media and Nationalism: Evidence from Serbian Radio in Croatia," *American Economic Journal: Applied Economics* 6, no. 3 (2011): 103.

[30] Maja Adena, Ruben Enikolopov, Maria Petrova, Veronica Santarosa and Ekaterina Zhuravskaya, "Radio and the Rise of The Nazis in Prewar Germany," *The Quarterly Journal of Economics* 130, no. 4 (2015): 1885.

[31] Adena, "Radio and the Rise of The Nazis in Prewar Germany," 1885.

[32] Adena, "Radio and the Rise of The Nazis in Prewar Germany," 1885.

effects of mass media. However, governments that maintain strict control over the content of broadcasts may utilize mass media assets as a tool to spread a particular narrative and unify the population. In accordance with those citing the pacifying effects of mass media, we offer the following hypothesis:

H2: Higher levels of mass media density decrease the probability of political revolution.

C. ECONOMIC DEVELOPMENT

Economic development, as measured by per capita GDP, is often cited as a critical factor in events leading to civil war and to civil unrest that may ultimately result in political revolution. Fearon and Laitin argue that higher GDPs reduce the probability of civil unrest and civil war, as higher GDP correlates positively to the state's ability to apply suppressive force against dissenting movements.[33] Evidence also suggests that higher per capita GDP and improvements in living standards promote democracy.[34] Epstein et al. found that "higher GDP does produce more democratic regimes…[and] higher GDP per capita reduces the probability that countries fall out of democracy."[35]

Karl Marx and others would argue that income inequality and a noticeable difference in the living standards between the ruling elites and the mass population will lead to popular revolution.[36] However, despite stark inequality between the ruling elites and the general population in North Korea, the North Korean regime has managed to survive, perhaps, due in part to the regime's effective police state and information monopoly.[37] This continued regime survival in the face of inequality seems to support

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[33] James D. Fearon and David D. Laitin, "Ethnicity, Insurgency and Civil War," *American Political Science Review* 97, no.1 (2003): 76.

[34] Robert J. Barro, "Determinants of Democracy," *Journal of Political Economy* 107, no. 6 (1999): 158.

[35] Barro, "Determinants of Democracy," 564.

[36] Daron Acemoglu and James A. Robinson, "A Theory of Political Transitions," *The American Economic Review* 91, No. 4 (2001): 939.

[37] Jiuen Baek, *North Korea's Hidden Revolution: How the Information Underground is Transforming a Closed Society* (New Haven & London: Yale University Press New, 2016): 39.

Thomas Apolte's argument that the real barrier to revolution is the lack of collective action.[38]

Based on a 2006 study, Hegre and Sambanis state, "[w]e conclude that a large population and low per capita income increase the risk of civil war, and this is consistent with many studies of civil war."[39] Collier and Hoeffler also find that higher levels of GDP correlate to reduced instances of civil conflict and unrest, citing the possibility that higher levels of income make civil war and unrest expensive for potential activists and rebels due to lost wages.[40] Rising per capita GDP may increase the opportunity costs for violence and reduce the incentive to advocate for political revolution.[41]

D. POPULATION DENSITY AND URBANIZATION

Scholars have pointed to the role that population density and urbanization rate play in state stability and political revolution. The communications infrastructure that is traditionally present in urban settings as compared to rural settings provides more people with access to the information environment which may play an important role in popular mobilization and political revolution.[42] Additionally, more concentrated populations that are found in urban settings are more likely to have access and exposure to a variety of information and information networks.[43] Epstein et al. found that higher urban populations destabilize democracy and that population density "promotes transitions out of autocracy but has no impact on partially or fully democratic regimes."[44] Collier and

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[38] Thomas Apolte, "Why is there no revolution in North Korea? The Political Economy of Revolution Revisited," Public Choice 150 (2010): 562.

[39] Havard Hegre and Nicholas Sambanis, "Sensitivity Analysis of Empirical Results on Civil War Onset," *The Journal of Conflict Resolution* 50, No. 4 (2006): 531.

[40] Paul Collier and Anke Hoeffler, "Greed and Grievance in Civil War," *Oxford Economic Papers* 56 (2004): 588.

[41] Paul Collier and Anke Hoeffler, "Greed and Grievance in Civil War," *Oxford Economic Papers* 56 (2004): 588.

[42] Peter G. Mwesige, "Cyber Elites: A Survey of Internet Café Users in Uganda," *Telematics and Informatics* 21, no. 1 (2004): 83.

[43] David H. Weaver, Judith M. Buddenbaum, and J.E. Fair, "Press Freedom, Media, and Development, 1950–1979: A Study of 134 Nations," *Journal of Communication* 35, no. 2 (1985): 104.

[44] David L. Epstein, Robert Bates, Jack Goldstone, Ida Kristensen and Sharyn O'Halloran, "Democratic transitions," *American Journal of Political Science* 50, no. 3 (2006): 563.

Hoeffler conclude that countries with highly concentrated populations "have a very low risk of conflict, whereas those with a highly-dispersed population have a very high risk [of conflict]."[45] Based on a 2004 study, Collier and Hoeffler state, "the risk of conflict is proportional to a country's population" which is said to be correlated with both opportunities and grievances as the population increases.[46] In a 2009 study, Hegre and Clionadh find that countries with large populations in which the population centers are geographically dispersed are more likely to experience revolution.[47] However, it may also be that as the number of cell phone users, coverage and infrastructure around the globe continues to increase, the physical proximity of individuals to one another will play a reduced role in future political revolutions.

[45] Epstein, "Democratic transitions," 581.

[46] Paul Collier and Anke Hoeffler, "Greed and Grievance in Civil War," *Oxford Economic Papers* 56, no. 4 (2004): 588.

[47] Havard Hegre and Clionadh Raleigh, "Population Size, Concentration, and Civil War: A Geographically Disaggregated Analysis," *Political Geography* 28, no. 4 (2009): 237.

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III. METHODOLOGY AND EMPIRICAL DATA

A. ANALYTICAL TIME FRAME

This study conducts a quantitative analysis of 167 countries with a minimum population of 500,000, covering a time period from 1945 to 2015. Fairly consistent records exist for this time period across the variables in the study, which allows for more accurate and complete results. The dependent variable is ***Political Revolution***, which is measured on the basis of rapid shifts toward more democratic or autocratic forms of government. The independent variable, ***Cell Phone Density***, is measured as the per capita number of cell phone subscribers, while ***Mass Media Density*** is measured as the per capita number of newspapers, radio receivers, and television receivers. The control variables for this study are per capita ***Gross Domestic Product (GDP)***, ***Population Density***, ***Urbanization***, ***Polity***, and ***Polity^2***. The portion of the study covering the time period from 1945 to 2000 includes all variables except the independent variable of cell phone subscribers per 100 people. Using the time period from 1945 to 2000 to assess the role that all variables, except cell phones, played in relation to *Political Revolution* allows for the analysis of data concerning the role that the control variables played in *Political Revolution* prior to and shortly after the advent of cell phones. Owing to the fact that cell phones did not have a presence in our data prior to 1981, the inclusion of cell phones in the study begins in 1980 and goes through 2015. The inclusion of cell phones in the portion of the study covering 1980 to 2015 allows for the analysis of the interaction of cell phones with the control variables in relation to *Political Revolution*.

B. DEFINING THE VARIABLES

The prime focus of this quantitative analysis is to explore and analyze the role that cell phone technologies have played in events that led to *Political Revolution*. We will also consider the role of older mass media technologies, in addition to a wide array of control variables.

1. Dependent Variable – Political Revolution

For the purpose of this study, each country is assigned an annual "*Polity*" score, or level of government, using data from the widely-recognized Center for Systemic Peace (CSP) *Polity IV Project: Political Regime Characteristics and Transitions, 1800–2015.*[48] The *Polity IV Project* provides a 21-point scale measuring regime types, ranging from -10 (full autocracy) to +10 (full democracy), with the regime categories of autocracies (-10 to -6), anocracies (-5 to +5) and democracies (+6 to +10).[49] The Polity IV dataset "covers all major, independent states in the global system over the period 1800 to 2015 (i.e., states with a total population of 500,000 or more in the most recent year; currently 167 countries)."[50] Examples of countries scoring a 10, or full democracy on the scale in 2015 are Sweden, Germany and the United States of America. In 2015, Saudi Arabia and North Korea are given a score of negative 10, or full autocracy. Countries classified as anocracies in 2015 include Russia with a score of 4, Bangladesh with a score of 1 and Afghanistan with a score of negative 1.

The dependent variable for all steps of the analysis is *Political Revolution*, either democratic or autocratic. Any country that experiences a change of 5 points or more in either direction on the Polity IV scale, which may be cumulative over a maximum period of up to three years, is counted as experiencing a *Political Revolution*. A shift of +5 or more on the Polity IV scale over a maximum period of three years will register as a democratic *Political Revolution*, and a shift of -5 or more over a maximum period of three years will register as autocratic *Political Revolution*. The dependent variable in this study is binary, meaning every year each country in the dataset is assigned either a 1 for autocratic or democratic *Political Revolution*, or a 0 for no *Political Revolution*.

It is important to note that based on the criteria of this study, a democratic *Political Revolution*, or a move up on the Polity IV scale of 5 or more over a

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48 "Center for Systemic Peace," The Polity Project, accessed June 09, 2017, http://www.systemicpeace.org/polityproject.html.

49 "Center for Systemic Peace," The Polity Project, accessed June 09, 2017, http://www.systemicpeace.org/polityproject.html.

50 "Center for Systemic Peace," The Polity Project, accessed June 09, 2017, http://www.systemicpeace.org/polityproject.html.

period of up to three years is not possible if the existing *Polity* level is 6 through 10. Similarly, an autocratic *Political Revolution*, or a move down on the Polity IV scale of 5 or more over a period of up to three years is not possible if the existing *Polity* level is negative 6 through negative 10. Additionally, this study does not account for revolutions, such as a military or elite led coup, or other change in regime leadership where the level of *Polity* does not change by 5 or more over a period of up to three years.

2. Independent Variable – Cell Phone Density

The independent variable for this study is *Cell Phone Density*, specifically cell phone subscriptions per 100 people within a country. The increased affordability and availability of cell phones provide a growing number of people and entities around the world with improved access to networks, information and real-time news. Additionally, these technologies have the potential to improve peoples' access to money, banking, markets, and the world economy. Values for *Cell Phone Density* were combined from the World Telecommunications Database,[51] the World Development Indicators Database,[52] and the Cross-National Time-Series Data Archive.[53] Missing values in each country series were interpolated using Stineman interpolation[54] and extrapolated using univariate exponential state-space smoothing models.[55]

3. Independent Variable – Mass Media Density

Mass Media Density is included in the study as a means "to capture the concept of variability in rates of mass media accessibility across societies."[56] As defined by T.

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[51] "World Telecommunications Database," International Telecommunications Union, accessed October 18, 2017, http://www.itu.int/ITU-D/ict/statistics/.

[52] "The World Bank," Data Bank: World Development Indicators, accessed June 09, 2017, http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators/.

[53] Arthur S. Banks, "Cross-National Time-Series Data Archive," Databanks International, 2004, https://www.cntsdata.com/.

[54] Russell W. Stineman, "A Consistently Well Behaved Method of Interpolation," *Creative Computing*, volume 6, number 7 (1980): 54–57.

[55] Rob Hyndman, Anne B Koehler, J Keith Ord, and Ralph D Snyder, *Forecasting with Exponential Smoothing: the State Space Approach* (Berlin: Springer Science & Business Media, 2008), 12.

[56] T. Camber Warren, "Not by the Sword Alone: Soft Power, Mass Media, and the Production of State Sovereignty," *International Organization* 68, no. 1 (2014): 124.

Camber Warren, the Media Density Index (MDI) is constructed on a country-year basis "where TV_{it} is equal to the number of television receivers in use for broadcasts to the general public in each country-year, $Radio_{it}$ is equal to the number of radio receivers in use for broadcasts to the general public, $Newspaper_{it}$ is equal to the circulation of daily newspapers (those published at least four times a week), and $Population_{it}$ is equal to the country's total population."[57] The MDI is used to measure the level of *Mass Media Density*. Following Warren, we construct the Media Density Index as follows:

$$MDI_{it} = \frac{TV_{it} + Radio_{it} + Newspaper_{it}}{Population_{it}} \times 100$$

Prior to the advent of the internet and cell phones, the technologies of radio, newspaper and television were the primary forms of media used for information dissemination and consumption. These means of communication provide governments with the ability to disseminate messages in support of a defined goal. The technologies that comprise the MDI serve as a powerful indicator of state power and "together serve as the ideal measure of variation in state capacities to produce soft power."[58] Values for the media penetration variables used to create the *Mass Media Density* variable were combined from the World Telecommunications Database,[59] the World Development Indicators Database,[60] and the Cross-National Time-Series Data Archive.[61] Missing values in each country series were interpolated using Stineman interpolation[62] and extrapolated using univariate exponential state-space smoothing models.[63]

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[57] T. Camber Warren, "Not by the Sword Alone: Soft Power, Mass Media, and the Production of State Sovereignty," *International Organization* 68, no. 1 (2014): 124.

[58] Warren, "Not by the Sword Alone," 124.

[59] "World Telecommunications Database," International Telecommunications Union, accessed October 18, 2017, http://www.itu.int/ITU-D/ict/statistics/.

[60] "The World Bank," *Data Bank: World Development Indicators*, accessed June 09, 2017, http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators/.

[61] Arthur S. Banks, "Cross-National Time-Series Data Archive," Databanks International, 2004, https://www.cntsdata.com/.

[62] Russell W. Stineman, "A Consistently Well Behaved Method of Interpolation," *Creative Computing*, volume 6, number 7(1980): 54–57.

[63] Rob Hyndman, Anne B Koehler, J Keith Ord, and Ralph D Snyder, *Forecasting with Exponential Smoothing: the State Space Approach* (Berlin: Springer Science & Business Media, 2008), 12.

4. Control Variables

To account for other factors that are commonly cited as influencing *Political Revolution*, this study also includes several control variables. Per capita *GDP* measures the level of economic development and wealth divided by the number of individuals in the country. Higher levels of per capita *GDP* have been shown to be an indicator of higher levels of development, improved infrastructure that supports communication, higher levels of individual satisfaction, and also higher rates of democratization. Higher levels of *Population Density* and *Urbanization*[64] rates may provide a greater opportunity for human interaction and communication and may also contribute to higher levels of violence and discontent, which may play a role in events leading to *Political Revolution*. Values for the *Population Density* and *GDP* variables were combined from Maddison's Historical Statistics,[65] Penn World Tables,[66] and the Institute for Health Metrics and Evaluation.[67] The data for the *Urbanization* rate is sourced from the World Bank World Development Indicators (WDI) database.[68] Regime types are measured using the 21-point scale from the Polity IV project discussed above.[69] *Polity* is used as a control to account for the level of democracy in a country at the time of *Political Revolution*. $Polity^2$, the quadratic term of *Polity*, is included to account for possible curvilinear effects. The curvilinear effect accounts for the possibility that anocratic regimes, which reside in the middle portion of the Polity IV scale, may be in a state of consolidation and

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[64] Urbanization refers to the urban population, which is defined by the World Bank as "people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects. Aggregation of urban and rural population may not add up to total population because of different country coverages." https://data.worldbank.org/indicator/SP.URB.TOT.

[65] Agnus Maddison, "Statistics on World Population, GDP, and Per Capita GDP 1–2008 AD," Groningen, Netherlands: Groningen Growth and Development Centre, University of Groningen, 2010, http://www.ggdc.net/maddison/maddison-project/home.htm.

[66] Robert C. Feenstra, Robert Inklaar, and Marcel P. Timmer, "The Next Generation of the Penn World Table," *American Economic Review* 105, no. 10 (2015): 3150–3182. www.ggdc.net/pwt.

[67] Spencer L. James, Paul Gubbins, Christopher J.L. Murray, and Emmanuela Gakidou, "Developing a Comprehensive Time Series of GDP Per Capita for 210 Countries from 1950 to 2015," *Population Health Metrics* 10, no. 12 (2012): 2.

[68] "The World Bank," Data Bank: World Development Indicators, accessed June 09, 2017, http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators/.

[69] "Center for Systemic Peace," The Polity Project, accessed June 09, 2017, http://www.systemicpeace.org/polityproject.html.

transition to either a more fully autocratic or democratic government. These anocracies may be more fragile than fully consolidated democracies or autocracies and therefore, more likely to experience *Political Revolution*. A study concerning the stability of anocracies found, "intermediate regimes are most prone to civil war, even when they have had time to stabilize from a regime change."[70] The higher probability of civil war in anocracies contributes to the instability of these regimes, which may result in a higher likelihood of *Political Revolution*.

5. Regression Model

For this research, the dependent variable – *Political Revolution* – is dichotomous; therefore, we utilize non-linear logistic regression models. According to the criteria of our study design, from 1945 through 2015, there were 97 autocratic *Political Revolutions* and 137 democratic *Political Revolutions*. The main purpose of the models is to conclude if there is a relationship between the independent variables and the probability of *Political Revolution*. Ultimately, the study seeks to determine the role, if any, that cell phone technologies play in democratic or autocratic *Political Revolutions*.

This study proceeds in a systematic manner and includes five steps. As shown in Table 1, Models 1 through 5 use democratic *Political Revolution* as the dependent variable and Models 6 through 10 use autocratic *Political Revolution* as the dependent variable. As shown in Models 1 and 6 in Table 1, the first step involves analysis of all countries in the study covering the time period from 1945 to 2000, using all variables except *Mass Media Density* and *Cell Phone Density*. As shown in Models 2 and 7 in Table 1, the second step involves analysis of all countries in the study covering a time period from 1945 to 2000, and adds *Mass Media Density* to the first step. As shown in Models 3 and 8 in Table 1, the third step uses the same set of variables as the second step, but now covers the years 1980 to 2015. As shown in Models 4 and 9 in Table 1, the fourth step includes all variables in the study, including *Cell Phone Density*, and covers

[70] Håvard Hegre, "Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816–1992," *American Political Science Review* 95, no. 1 (2001): 33.

the time period from 1980 to 2015. As shown in Models 5 and 10, the final step uses the same criteria as in step four, except the final step includes country-level fixed effects.

All variables are categorized in country-year format. In order to guard against reverse causation all independent variables are lagged by one year. Using last year's value of level of technology penetration to predict this year's value of revolution will help provide more confidence that the causal arrow is pointing in the correct direction. Two of the control variables also display heavy-tailed distributions; therefore, the models involve a logarithmic transformation to per capita *GDP* and *Population Density*.

Table 1. Non-linear Logistic Regression Results: Models 1–10

Non-linear Logistic Regression Results: Models 1-10

	Dependent variable:									
	Democratic Political Revolution					Autocratic Political Revolution				
	1945-2000			1980-2015		1945-2000			1980-2015	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
per capita GDP	0.227	0.114	0.032	0.092	-0.684	-0.607***	-0.277	-0.696**	-0.686**	-1.871
	(0.167)	(0.179)	(0.189)	(0.193)	(0.731)	(0.190)	(0.216)	(0.276)	(0.278)	(1.241)
Population Density	-0.004	-0.042	-0.073	-0.060	1.999**	-0.076	-0.044	0.128	0.129	0.503
	(0.063)	(0.065)	(0.075)	(0.076)	(0.949)	(0.079)	(0.084)	(0.125)	(0.125)	(1.574)
Urbanization	0.0004	-0.0001	-0.001	-0.001	0.006	-0.0002	0.001*	0.0004	0.0005	-0.006
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)
Polity	-0.172***	-0.180***	-0.210***	-0.203***	-0.347***	0.267***	0.262***	0.293***	0.294***	0.491***
	(0.036)	(0.036)	(0.037)	(0.038)	(0.049)	(0.041)	(0.039)	(0.081)	(0.081)	(0.116)
Polity Squared	-0.046***	-0.048***	-0.044***	-0.045***	-0.052***	-0.041***	-0.037***	-0.034***	-0.034***	-0.024*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.009)	(0.006)	(0.006)	(0.011)	(0.011)	(0.014)
Mass Media Density		0.001**	0.001*	0.001*	0.003**		-0.003***	-0.0001	-0.0001	0.006***
		(0.0004)	(0.0004)	(0.0004)	(0.001)		(0.001)	(0.001)	(0.001)	(0.002)
Cell Phone Density				-0.012**	-0.023**				-0.002	-0.013
				(0.005)	(0.009)				(0.005)	(0.012)
Constant	-4.784***	-4.341***	-3.811**	-4.036***	2.143	0.509	-1.549	1.911	1.855	-4.877
	(1.330)	(1.400)	(1.533)	(1.549)	(7,975.977)	(1.483)	(1.639)	(2.155)	(2.164)	(19,350.250)
Fixed effects	No	No	No	No	Yes	No	No	No	No	Yes
Observations	6,748	6,548	5,213	5,206	5,206	6,748	6,548	5,213	5,206	5,206
Log Likelihood	-483.769	-474.330	-387.134	-382.974	-292.177	-353.157	-343.803	-191.439	-191.352	-125.555
Akaike Inf. Crit.	979.538	962.659	788.268	781.948	918.353	718.314	701.605	396.879	398.703	585.110
Note:										*p<0.1; **p<0.05; ***p<0.01

IV. ANALYSIS OF EMPIRICAL DATA

In Table 1, democratic *Political Revolution* serves as the dependent variable for Models 1 through 5. Model 1 serves as a baseline measurement and includes all of the variables except *Mass Media Density* and *Cell Phone Density*, and covers the years 1945 to 2000. Model 2 adds *Mass Media Density* to the baseline measurement. Model 3 maintains the same variables as Model 2, but covers 1980 to 2015. Model 4 and Model 5 cover the same time period as Model 3, but add *Cell Phone Density* and now include all the variables in the study. As a robustness check, Model 5 adds country level fixed effects. Models 6 through 10 are structured in the same manner as Models 1 through 5. However, in Models 6 through 10, autocratic *Political Revolution* serves as the dependent variable.

The AIC (Akaike Information Criterion) score is used to measure the predictive success of models and the most suitable model among a group of models is that which minimizes the AIC.[71] As illustrated in Table 1, Model 4 has the lowest AIC score among the models that use democratic *Political Revolution* as the dependent variable, indicating that both *Mass Media Density* and *Cell Phone Density* increase the accuracy of the prediction of shifts toward more democratic political structures. Model 8 has the lowest AIC score among the models that use autocratic *Political Revolution* as the dependent variable, indicating that *Mass Media Density* improves the power of the model to predict shifts towards more autocratic political structures, but *Cell Phone Density* does not.

Notable findings are as follows: there is a strong negative relationship between cell phone use and democratic *Political Revolutions*, suggesting that higher levels of cell phone use actually reduce the likelihood of democratic *Political Revolution*, and may bolster existing autocracies. Additionally, there is a strong positive relationship between *Mass Media Density* and democratic *Political Revolution*, suggesting that higher levels of *Mass Media Density* actually increase the likelihood of democratic *Political Revolution*.

[71] Hirotugu Akaike, "A New Look at the Statistical Model Identification," *IEEE Transactions on Automatic Control* 19, no. 6 (1974): 716.

The level of *Polity*, or government, is by far the most predictive indicator of *Political Revolution*.

As detailed in Table 1, Model 1 covers the time period 1945 to 2000 and uses democratic *Political Revolution* as the dependent variable. In Model 1, the statistically significant regression coefficient for both *Polity* and *Polity*^{2} are negative (both $p < 0.01$). The lack of statistical significance for per capita *GDP*, *Population Density* and *Urbanization* rate when democratic *Political Revolution* is the dependent variable indicates that there is not enough evidence to infer a relationship between these variables and democratic *Political Revolution*.

In Model 2, with the addition of *Mass Media Density*, *Polity* and *Polity*^{2} maintain a statistically significant negative regression coefficient (both $p < 0.01$). The statistically significant regression coefficient for *M*ass *Media Density* is positive ($p < 0.05$). This finding indicates that from 1945 to 2000, higher levels of *Mass Media Density* contributed to a higher likelihood of democratic revolution. The time period for Model 3 covers 1980 to 2015, and includes all variables except *Cell Phone Density*. The statistically significant regression coefficient for *Polity* and *Polity*^{2} *are* negative (both $p < 0.01$) and for *Mass Media Density* is positive ($p < 0.10$), again indicating that higher levels of *Mass Media Density* increase the probability of democratic *Political Revolution*.

As detailed in Table 1, the statistically significant regression coefficient for *Polity* and *Polity*^{2} (Figure 1) in Model 4 are negative (both $p < 0.01$). It is important to note that in addition to being statistically significant, the results are also substantively significant, meaning a shift in the independent variable results in a large shift in the dependent variable. This is highlighted in Figure 1, which displays how the probability of democratic *Political Revolution*, shown on the y-axis, changes under different levels of *Polity*, shown on the x-axis. The results in Model 4 suggest that democratic *Political Revolution*, or a shift up on the Polity IV scale, is most likely to occur when the level of *Polity* is roughly negative 2 on the Polity IV scale. According to the results illustrated in Figure 1, during the period from 1980 to 2015, there is a roughly 40% higher probability that democratic *Political Revolution* will occur when the level of *Polity* is between negative 2 and negative 3 than when the level of *Polity* is negative 5. When the level of

Polity is between negative 2 and negative 3, there is a roughly 160% higher probability that democratic *Political Revolution* will occur than when the level of *Polity* is positive 5.

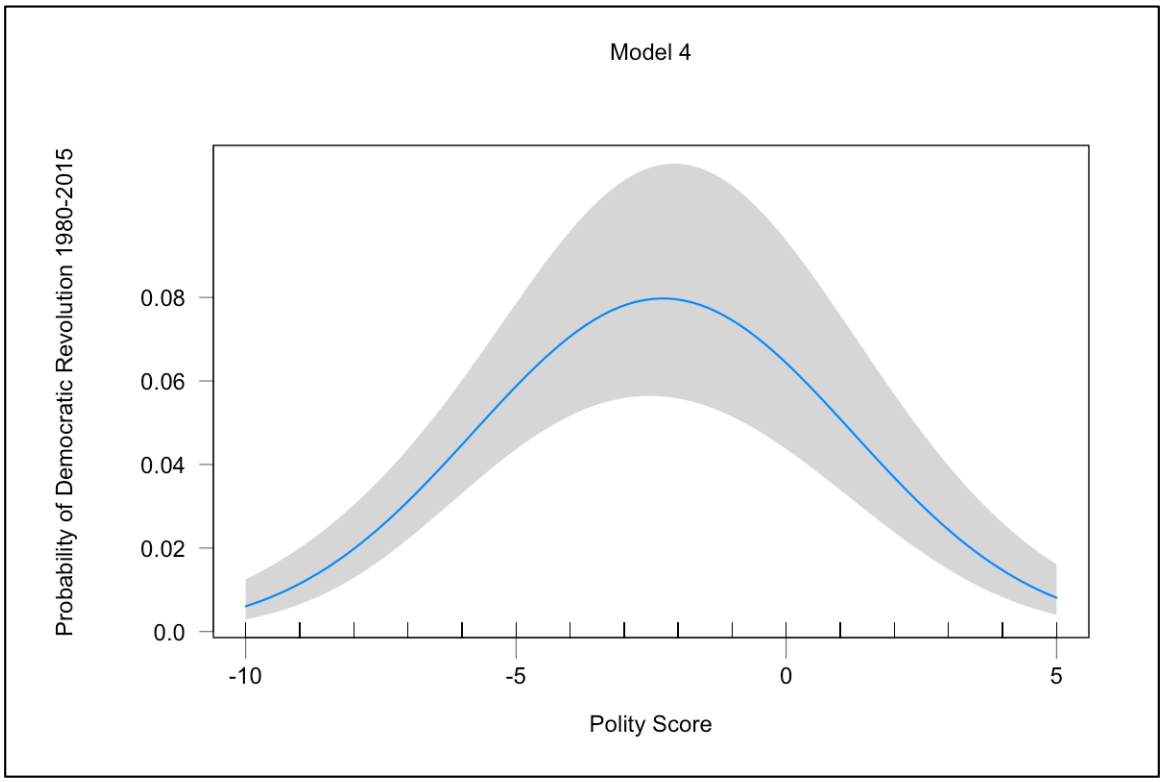

Figure 1 illustrates the findings from Model 4 (Table 1), demonstrating a statistically significant regression coefficient for *Polity* and *Polity*^{2}. In Figure 1, democratic *Political Revolution* serves as the dependent variable and *Polity* serves as the independent variable. The shaded, semi-transparent region represents a 95% confidence interval for the estimated effect.

Figure 1. Probability of Democratic Political Revolution as a Function of the Polity Score

In Model 4, the results for *Mass Media Density* (Figure 2) are statistically and substantively significant. The moderately significant regression coefficient for *Mass Media Density* is positive ($p < 0.10$), indicating that higher levels of *Mass Media Density* may increase the likelihood of democratic *Political Revolution*, or a shift up on the Polity IV scale. As illustrated in Figure 2, democratic *Political Revolutions* are more than twice as likely to occur when the *Media Density Index* is around 2000 than when MDI is

around 50. This finding does contradicts the expectations of *Hypothesis 2*, which predicted that higher levels of *Mass Media Density* would decrease the probability of revolution.

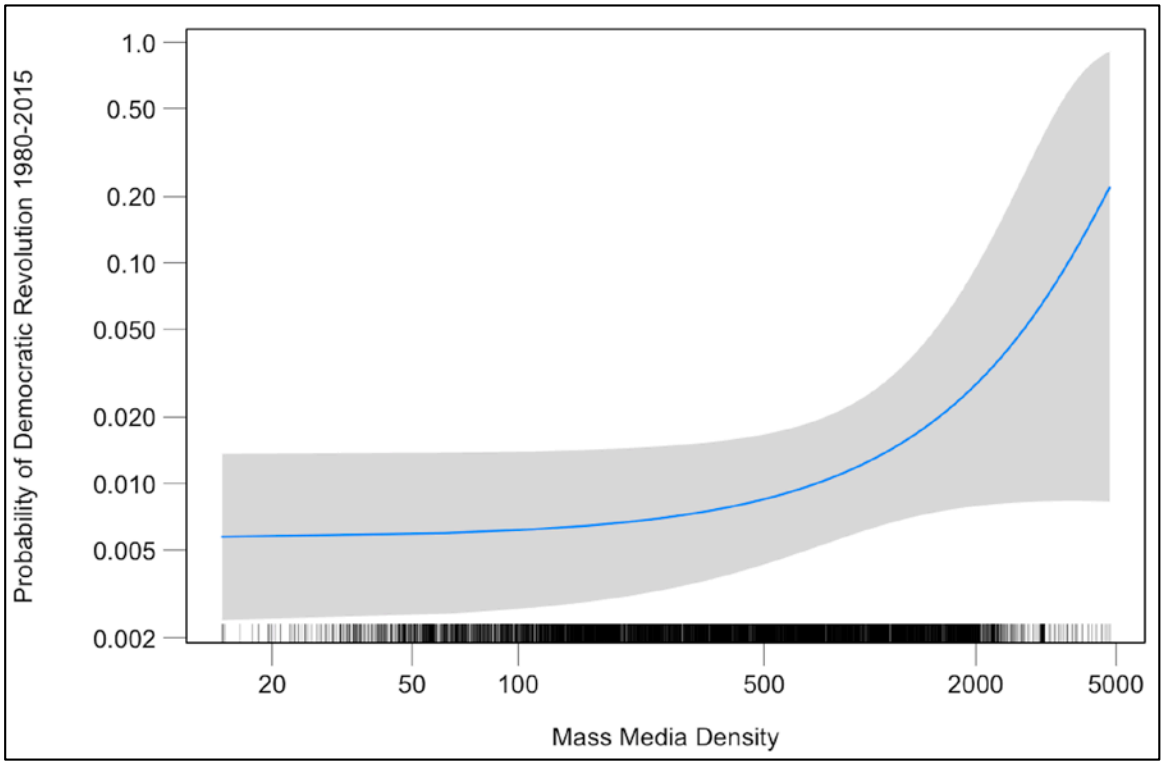

Figure 2 illustrates the findings from Model 4 (Table 1), demonstrating a statistically significant positive regression coefficient for *Mass Media Density*, suggesting higher levels of *Mass Media Density* contribute to a higher likelihood of democratic *Political Revolution*. In Figure 2, democratic *Political Revolution* serves as the dependent variable and *Mass Media Density* serves as the independent variable, with log transformation applied to both the x and the y axes. The shaded, semi-transparent region represents a 95% confidence interval for the estimated effect.

Figure 2. Probability of Democratic Political Revolution as a Function of Mass Media Density

In Model 4, the results for *Cell Phone Density* (Figure 3) are also statistically and substantively significant. In Figure 3, on the y-axis, "Probability of Democratic Revolution 1980–2015" serves as the dependent variable. On the x-axis, *Cell Phone Density* serves as the independent variable. The statistically significant regression coefficient for *Cell Phone Density* is negative ($p < 0.05$). The results suggest that higher

levels of *Cell Phone Density* decrease the probability of democratic *Political Revolution* or a shift up on the Polity IV scale. As demonstrated in Figure 3, the probability of democratic *Political Revolution* decreases by roughly 75% when the Cell Phone Density increases from 0 to 150. This finding contradicts the expectations of *Hypothesis 1*, which predicted that higher rates of cell phone density would increase the probability of *Political Revolution*. In Models 4 and 5, the statistically significant regression coefficients for *Polity*, *Polity*^{2}, *Mass Media Density* and *Cell Phone Density* are present with and without country level fixed effects in the model, indicating that these results are fairly robust.

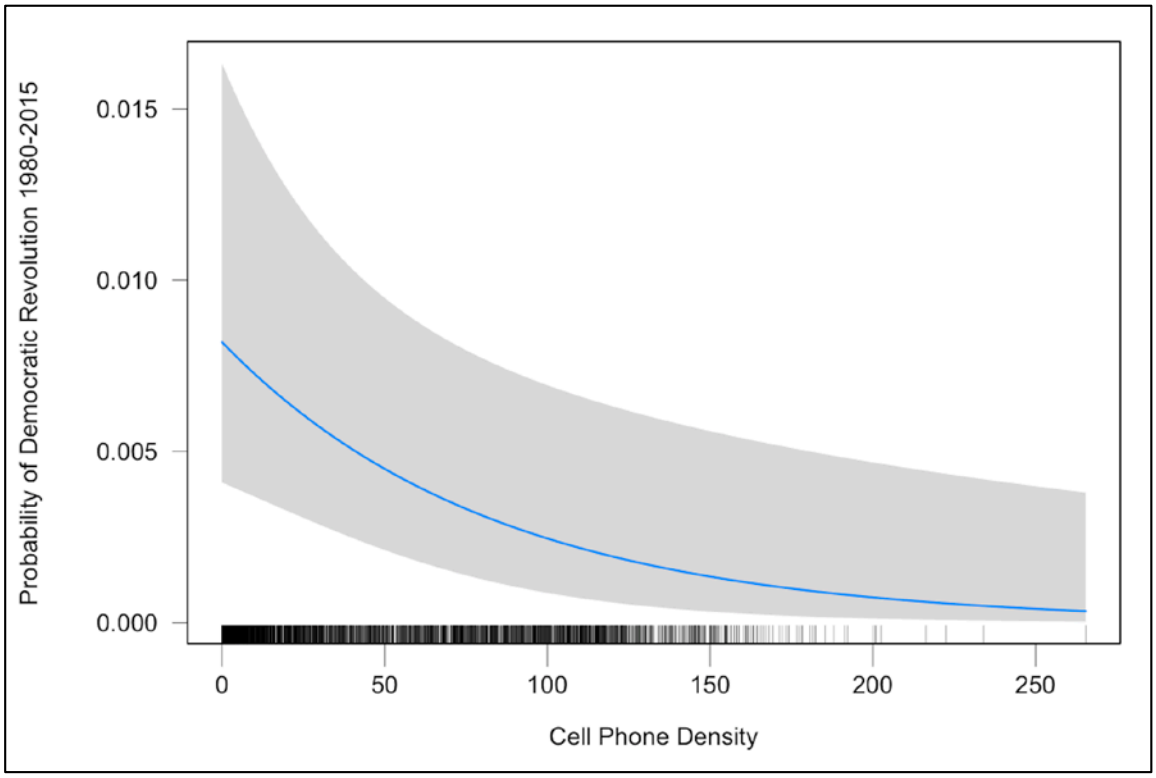

Figure 3 illustrates the findings from Model 4 (Table 1), demonstrating a statistically significant negative regression coefficient, suggesting higher levels of *Cell Phone Density* contribute to a lower likelihood of democratic *Political Revolution*. In Figure 3, democratic *Political Revolution* serves as the dependent variable and *Cell Phone Density* serves as the independent variable. The shaded, semi-transparent region represents a 95% confidence interval for the estimated effect.

Figure 3. Probability of Democratic Political Revolution as a Function of Cell Phone Density

In Models 6 through 10, autocratic *Political Revolution* is the dependent variable. As detailed in Table 1, Model 6 and Model 7 cover the time period from 1945 to 2000. In Model 6, the statistically significant regression coefficient for per capita *GDP* is negative ($p < 0.01$), indicating that higher levels of per capita *GDP* reduce the probability of autocratic *Political Revolution*. The statistically significant regression coefficient for *Polity* is positive ($p < 0.01$), but for $Polity^2$ it is negative ($p < 0.01$). However, as illustrated in Model 7, when adding *Mass Media Density*, the model no longer displays statistical significance for per capita *GDP*, but maintains a statistically significant positive regression coefficient for *Polity* ($p < 0.01$) and a statistically significant negative regression coefficient for $Polity^2$ ($p < 0.01$). The addition of the statistically significant negative regression coefficient of *Mass Media Density* ($p < 0.01$) to Model 7 appears to nullify the statistical significance of per capita *GDP*. This indicates that higher levels of *Mass Media Density* decrease the probability of autocratic *Political Revolution*.

In Model 8, autocratic *Political Revolution* serves as the dependent variable and covers the time period from 1980 to 2015. Using the same variables as Model 7, but changing the time period covered, Model 8 no longer displays statistical significance for *Mass Media Density* or *Urbanization* rate, but does display a statistically significant negative regression coefficient for per capita *GDP* ($p < 0.05$). This finding indicates that higher levels of per capita *GDP* reduce the likelihood of autocratic *Political Revolution* during the 1980 to 2015 time period. These results also indicate that higher levels of wealth tend to stabilize existing democracies, at least in more recent years. Additionally, *Polity* maintains a statistically significant positive regression coefficient ($p < 0.01$). $Polity^2$ maintains a statistically significant negative regression coefficient ($p < 0.01$).

As detailed in Table 1, autocratic *Political Revolution* serves as the dependent variable for Model 9 and covers the time period from 1980 to 2015. Model 9 is structured in the same way as Model 8, but adds *Cell Phone Density* to the Model. It is important to note that the addition of *Cell Phone Density* does not impact the statistical significance of any of the variables in comparison to Model 8. Furthermore, the addition of *Cell Phone Density* does not lower the AIC score, indicating that *Mass Media Density* does improve the predictive power of the model, but *Cell Phone Density* does not. As detailed in Table

1, the results for *GDP* are both statistically and substantively significant. In Figure 4, on the y-axis, "Probability of Autocratic Revolution 1980–2015" serves as the dependent variable. On the x-axis, "per capita *GDP"* serves as the independent variable. The statistically significant regression coefficient for per capita *GDP* (Figure 4) is negative ($p < 0.05$). This suggests that higher levels of per capita *GDP* contribute to a lower likelihood of autocratic *Political Revolution*, or a shift down on the Polity IV scale. As demonstrated in Figure 4, an increase in the per capita *GDP* from around six-thousand U.S. dollars to around ten-thousand U.S. dollars reduces the probability of autocratic *Political Revolution* by around 90%. Similar to Model 8, we could also infer that higher levels of per capita *GDP*, or wealth, perform a stabilizing function in existing democracies. Statistical significance for *Cell Phone Density* is not present in Model 9, suggesting that there is insufficient information to determine whether *Cell Phone Density* plays a significant role in events leading to autocratic revolution.

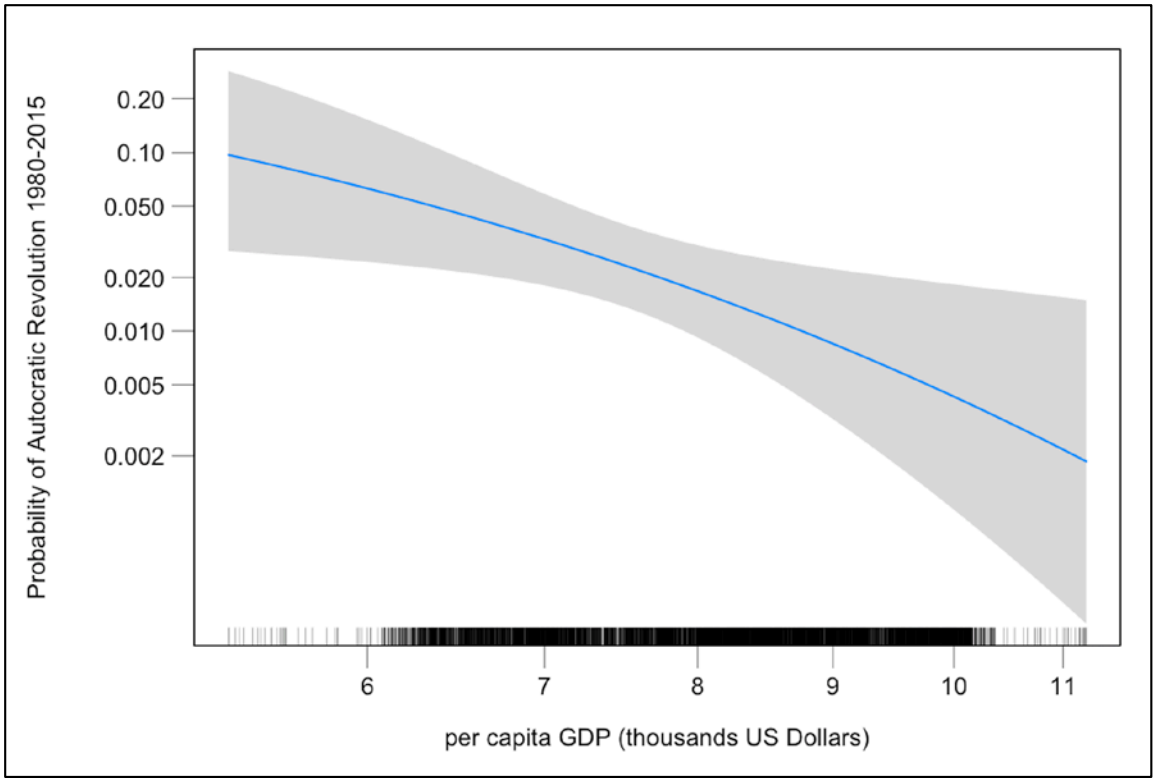

Figure 4 illustrates the findings from Model 9 (Table 1), demonstrating a statistically significant negative regression coefficient, suggesting higher levels of per capita *GDP* contribute to a lower likelihood of autocratic *Political Revolution*. This also indicates that higher levels of per capita *GDP*, or wealth, stabilize existing democracies. In Figure 4, autocratic *Political Revolution* serves as the dependent variable and per capita *GDP* serves as the independent variable, with log transformation applied to both the x and the y axes. The shaded, semi-transparent region represents a 95% confidence interval for the estimated effect.

Figure 4. Probability of Autocratic Political Revolution as a Function of Per Capita GDP

In Model 9, the statistically significant regression coefficient for *Polity* (Figure 5) is positive ($p < 0.01$), and for $Polity^2$ it is negative ($p < 0.01$). In Figure 5, on the y-axis, "Probability of Autocratic Revolution 1980–2015" serves as the dependent variable. On the x-axis, "*Polity* Score" serves as the independent variable. Figure 5 suggests that autocratic *Political Revolution* is most likely to occur when the level of *Polity*, or government, is around 4 on the Polity IV scale. According to the results illustrated in Figure 5, during the period from 1980 to 2015, there is a roughly 5% higher probability that autocratic Political Revolution will occur when the level of Polity is around 4 than when the level of Polity is around 5. There is a roughly 7 times higher probability that

autocratic Political Revolution will occur when the level of Polity is around 4 than when the level of Polity is around negative 5.

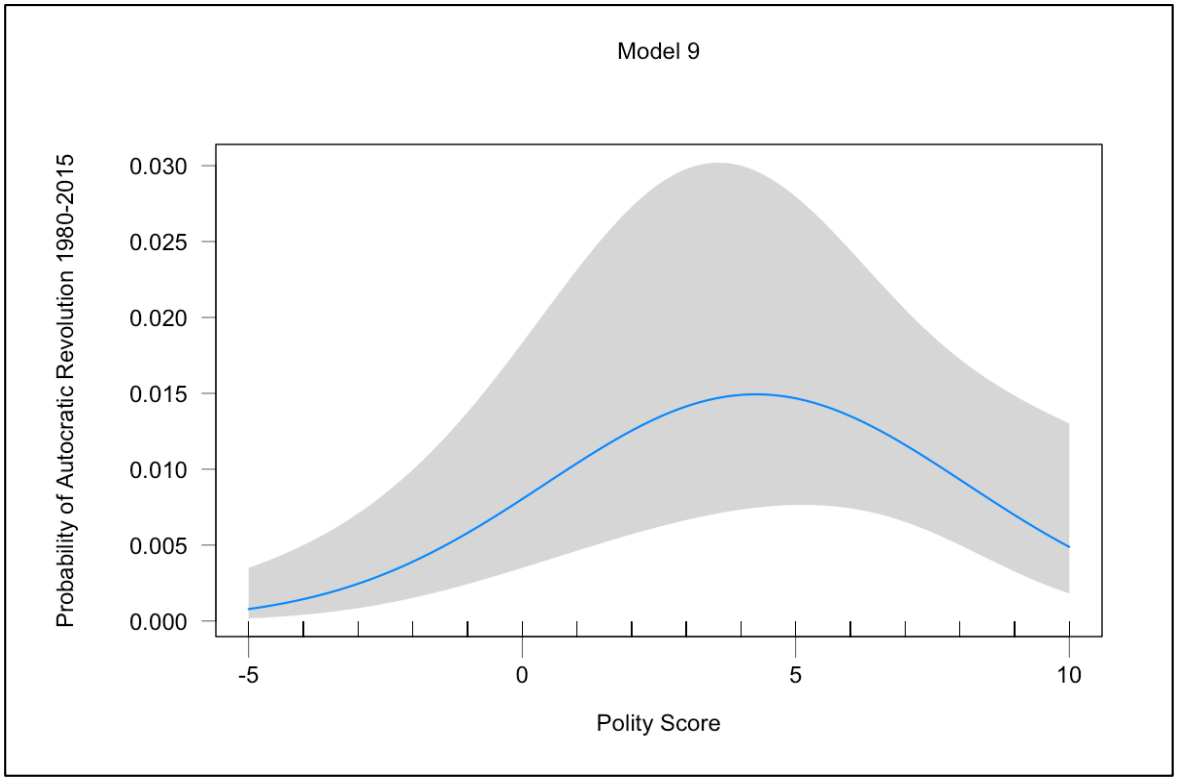

Figure 5 illustrates the findings from Model 9 (Table 1), demonstrating a statistically significant regression coefficient for *Polity and Polity*^{2}. The result is also substantively significant. This suggests that autocratic *Political Revolution*, or a shift down on the Polity IV scale, is most likely to occur when the level of *Polity* is around positive 4 on the Polity IV scale. In Figure 5, autocratic *Political Revolution* serves as the dependent variable and *Polity* serves as the independent variable. The shaded, semi-transparent region represents a 95% confidence interval for the estimated effect.

Figure 5. Probability of Autocratic Political Revolution as a Function of the Polity Score

The findings in Model 9 do not support *Hypotheses 1* or *2*. The lack of statistical significance for the variables of *Mass Media Density* and *Cell Phone Density* indicate that there is not enough evidence to infer a relationship between these two variables and autocratic *Political Revolution*.

As displayed in Model 9 and Model 10 in Table 1, it is important to note that *Polity* and *Polity*^{2} maintain statistical significance with and without country level fixed effects in the Model, indicating that these results are fairly robust.

A. MODEL ASSESSMENT

One method used to measure a model's predictive capacity is through the use of the AIC score. In order to measure a model's predictive ability, AIC provides a score based on a model's suitability for a dataset, while also penalizing the model for its complexity.[72] Better predictive ability is represented by lower AIC scores. AIC scores are displayed in the bottom row of Table 1. As displayed in Models 2, 3, 7 and 8, the addition of *Mass Media Density* in the model lowers the AIC scores in comparison to Model 1 and 6, which do not include *Mass Media Density* or *Cell Phone Density*. As displayed in Model 4 (AIC=781.948), the addition of *Cell Phone Density* to the Model results in the lowest AIC score among those models that have democratic *Political Revolution* as the dependent variable. Despite its increased complexity, Model 4 does a better job of forecasting democratic *Political Revolution* than Models 1, 2, 3 or 5.

In Models 6 through 10, autocratic *Political Revolution* serves as the dependent variable. As displayed in Models 6 through 8, the addition of *Mass Media Density* lowers the AIC score. As displayed in Model 8 (AIC = 396.876), the addition of *Mass Media Density* results in the lowest AIC score and improves the predictive power of the Model. As illustrated in Model 9, the addition of *Cell Phone Density* does not result in a lower AIC score, indicating that *Cell Phone Density* does not improve the predictive power of the model.

The use of receiver operating characteristic (ROC) curves is another way to test whether *Cell Phone Density* is a useful forecaster of the dichotomous result of *Political Revolution* within countries or whether it only serves as a proxy for other variables present within a country. The production of ROC curves for Models 3 and 4 (Figure 6) and Models 8 and 9 (Figure 7) provide a graphic representation of which models

[72] Hirotugu Akaike, "A New Look at the Statistical Model Identification," *IEEE Transactions on Automatic Control* 19, no. 6 (1974): 716.

outperform others in predictive situations. In using ROC curves, measuring the area under the curve (AUC) is used to analyze the predictive power of models. More accurate models will display a greater AUC. When analyzing Models 3 and 4, Model 4 has the higher AUC score (AUC = .828) compared to Model 3 (AUC = .818). This indicates that the inclusion of *Cell Phone Density* in Model 4 results in higher levels of predictive capacity. In conducting an analysis of Models 8 and 9, Model 9 has the higher AUC score (AUC = .8346) compared to Model 8 (AUC = .8342). This indicates that the inclusion of *Cell Phone Density* in the model results in higher levels of predictive capacity, though the difference here is quite small.

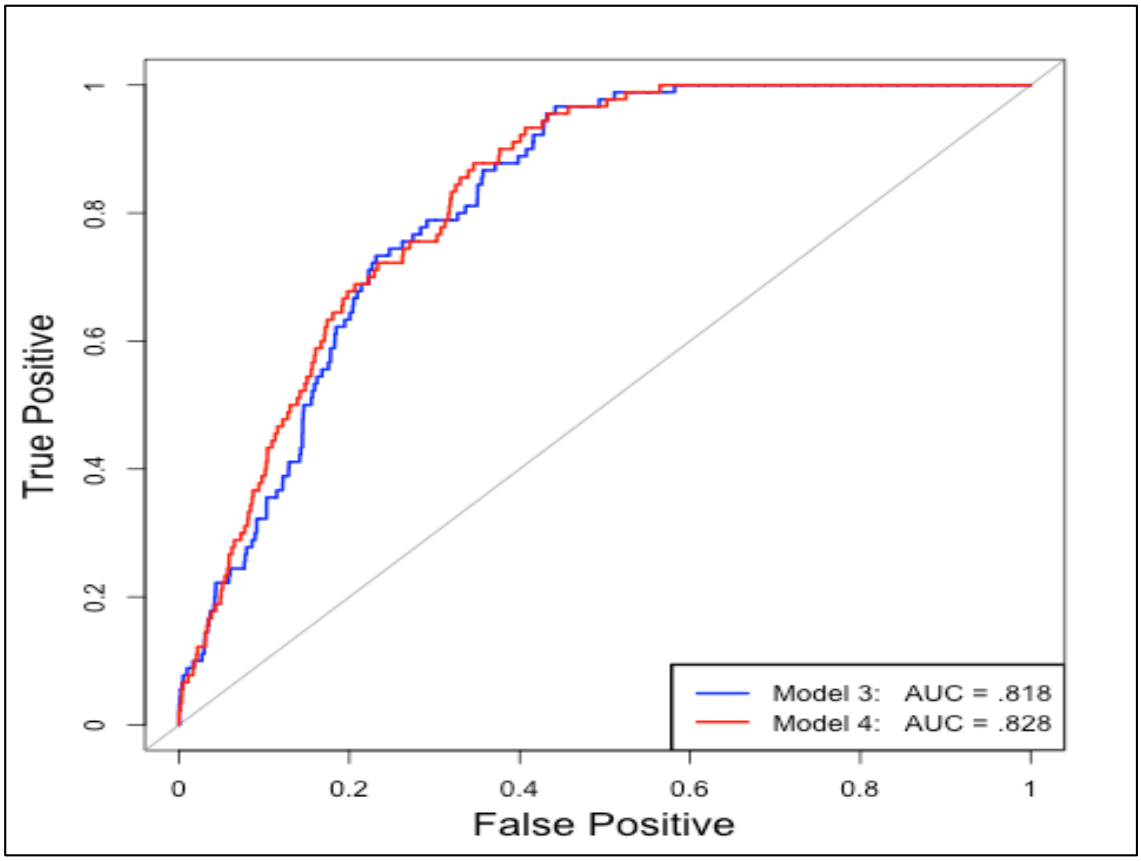

Figure 6 illustrates the AUC score for Model 3 and Model 4 (ref. Table 1). Model 4, which includes *Cell Phone Density*, has the higher AUC score (AUC = .828) compared to Model 3, which does not include *Cell Phone Density* (AUC = .818). This indicates that the inclusion of *Cell Phone Density* in the model results in higher levels of predictive capacity.

Figure 6. ROC Curve (Model 3 and 4)

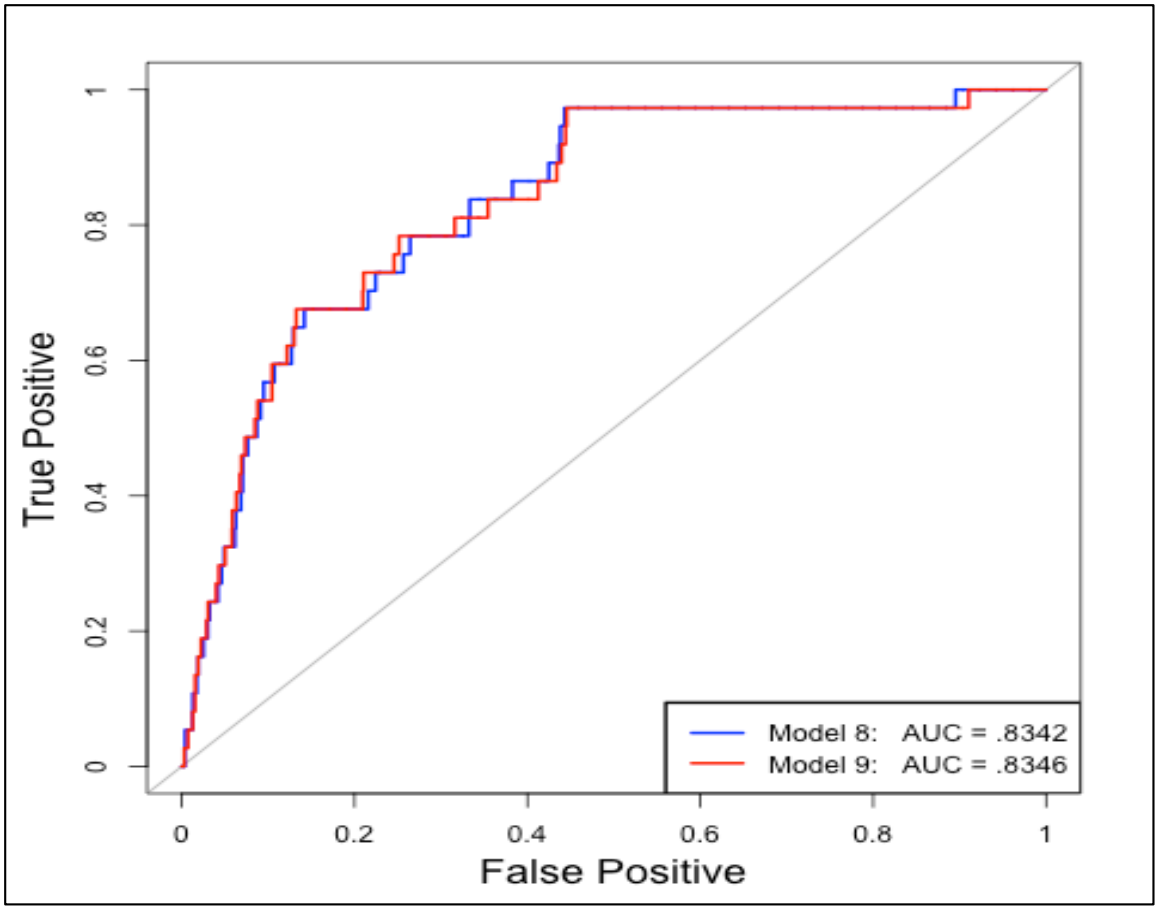

Figure 7 illustrates the AUC score for Model 8 and Model 9 (ref. Table 1). Model 9 has the higher AUC score (AUC = .8346) compared to Model 8 (AUC = .8342). This indicates that the inclusion of *Cell Phone Density* in Model 9 results in higher levels of predictive capacity.

Figure 7. ROC Curve (Model 8 and 9)

B. SUMMARY OF RESULTS

The analyses conducted addressed the two hypotheses presented in the study. Contrary to *Hypothesis 1*, the results indicate that higher levels of *Cell Phone Density* do not increase the probability of *Political Revolution*. In fact, higher levels of *Cell Phone Density* contribute to a lower likelihood of democratic *Political Revolution*. Regarding the role that *Cell Phone Density* plays when autocratic *Political Revolution* is the dependent variable, we cannot infer a relationship between autocratic *Political Revolution* and *Cell Phone Density*.

Contrary to *Hypothesis 2*, higher levels of *Mass Media Density* consistently increase the probability of democratic *Political Revolution*. As illustrated in Model 7, higher levels of *Mass Media Density* during the time period covering 1945 to 2000 reduced the likelihood of autocratic *Political Revolution*. We could also interpret the results in Model 7 to mean that higher levels of *Mass Media Density* strengthen existing democracies. When autocratic *Political Revolution* is the dependent variable, as illustrated in Models 8 and 9, there is not enough evidence to infer a relationship between *Mass Media Density* and autocratic *Political Revolution* in more recent years.

GDP does not appear to play a consistent role in democratic *Political Revolution*. However, as displayed in Models 6, 8 and 9, higher levels of per capital *GDP* inhibit autocratic *Political Revolution*, or a shift down on the Polity IV scale. This finding also indicates that higher levels of per capita *GDP* serve to strengthen existing democracies. In Model 7, the results also suggest that higher levels of *Urbanization* may increase the probability of autocratic *Political Revolution*, but this finding is not robust across specifications.

As illustrated throughout Table 1, the level of *Polity* is by far the most predictive indicator of *Political Revolution*. In accordance with Hegre's findings,[73] *Political Revolution* is most likely to occur in regimes that are considered anocracies on the Polity IV scale. However, this study also finds that different types of *Political Revolution*, either democratic or autocratic, are most likely to occur in countries with governments that fall within different range on the Polity IV scale.

Throughout all models that use democratic *Political Revolution* as the dependent variable (Figure 8), democratic *Political Revolution* is most likely to occur when the level of *Polity* is between roughly -4 and -2. Throughout all models that use autocratic *Political Revolution* as the dependent variable (Figure 9), autocratic *Political Revolution* is most likely to occur when the level of *Polity* is between roughly 4 and 5. These findings indicate that strong democracies (polity > 5) and strong autocracies (polity < -5) are less likely to experience a *Political Revolution*.

[73] Håvard Hegre, "Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816–1992," *American Political Science Review* 95, no. 1 (2001): 33.

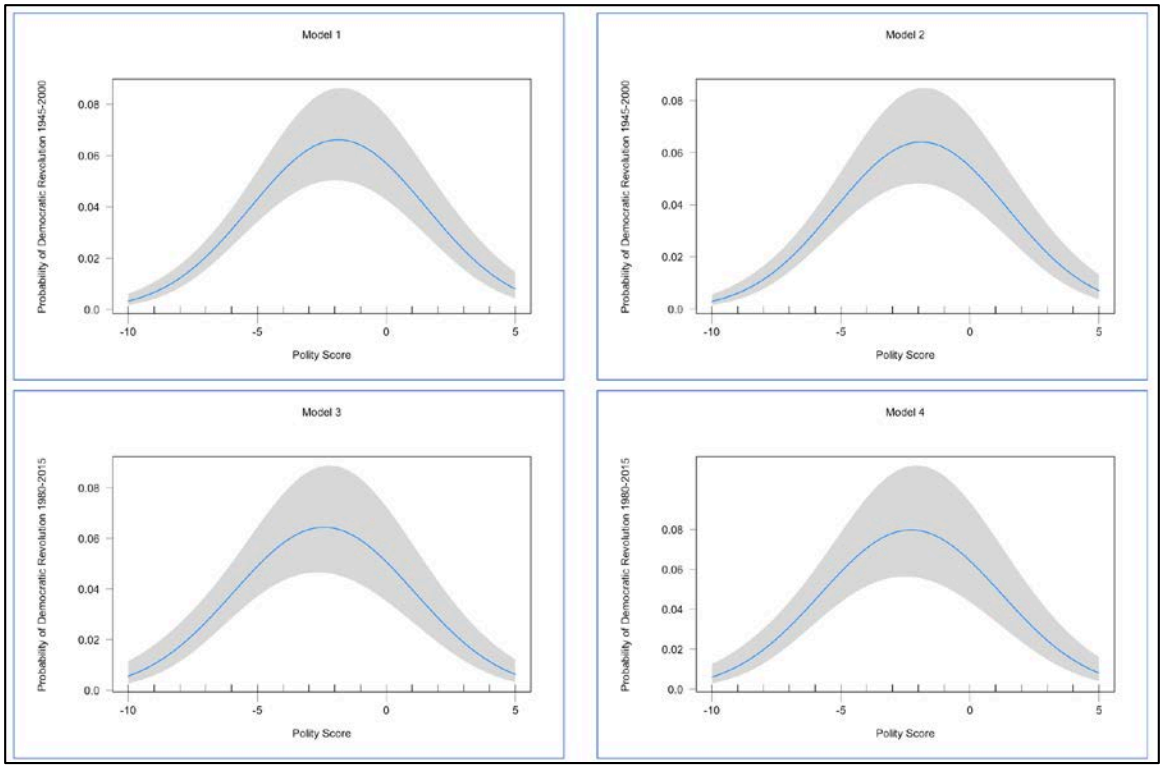

Figure 8 illustrates the statistically and substantively significant results for *Polity* in Models 1 through 4. For all these Models, democratic *Political Revolution* serves as the dependent variable and *Polity* Score serves as the independent variable. Throughout all Models, the results indicate that democratic *Political Revolution* is most likely to occur when the level of *Polity* is between roughly -4 and -2. The shaded, semi-transparent region represents a 95% confidence interval for the estimated effect.

Figure 8. Democratic Political Revolution and Polity

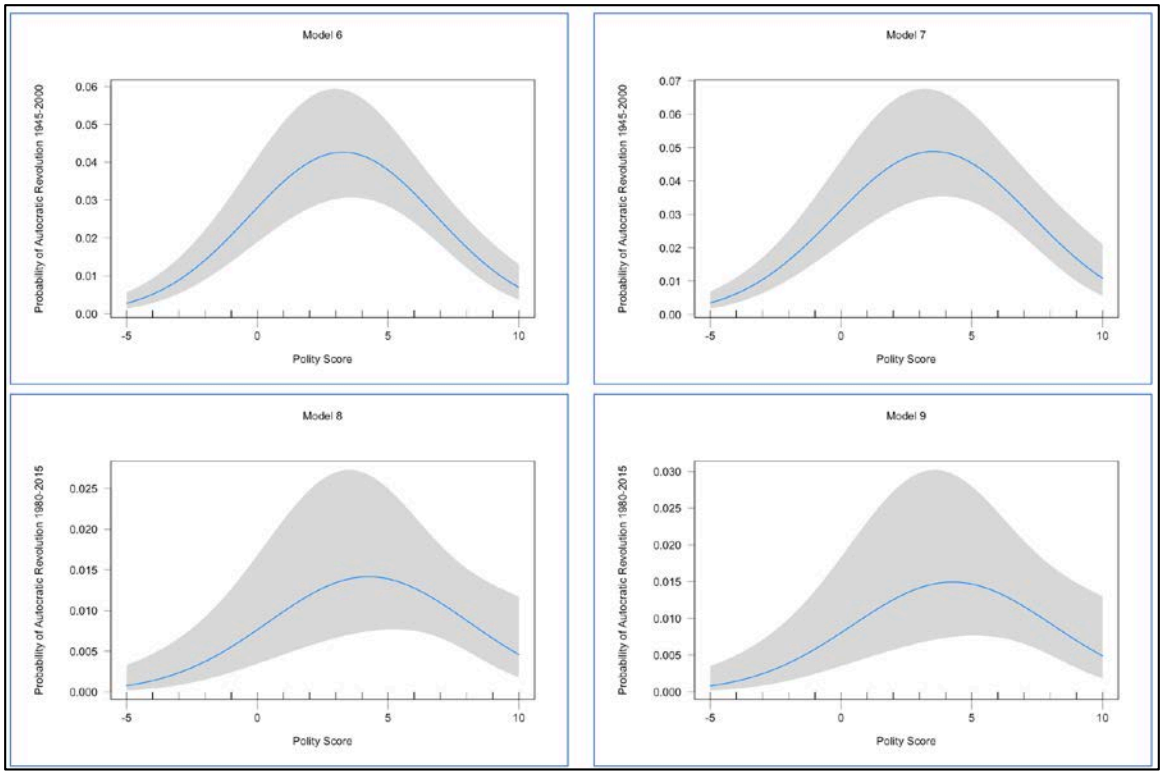

Figure 9 illustrates the statistically and substantively significant results for *Polity* in Models 6 through 9. For all these Models, autocratic *Political Revolution* serves as the dependent variable and *Polity* Score serves as the independent variable. Throughout all Models the results indicate that autocratic *Political Revolution* is most likely to occur when the level of *Polity* is between roughly 4 and 5. The shaded, semi-transparent region represents a 95% confidence interval for the estimated effect.

Figure 9. Autocratic Political Revolution and Polity

C. IMPLICATIONS AND PROJECTIONS

While there are many different variables that play a role in *Political Revolution*, this thesis identifies some important trends and sheds light on particular aspects of human interaction with cell phones and mass media that can help us better understand their role in revolution. Based on the results of this thesis, policy makers may conclude that higher levels of cell phone use may bolster existing autocratic governments and reduce the likelihood of democratic *Political Revolution*. While cell phones seem to create novel and low cost methods of communication and coordination, the liberating potential of cell phones may be overstated in regards to political revolution. This may be due in part to the potential organizational challenges associated with the horizontal nature of

communications enabled by cell phones. As smart phones become more common and replace traditional push-button cell phones, these devices may provide another venue for media to perform a placating role in society. The increasing availability of games and other entertainment available through cell phones may cause prospective activists and reformers to spend more time chasing imaginary monsters and watching cat videos on their small screens and less time contemplating the ills of society and government.

The findings concerning *Cell Phone Density* may also reinforce the importance of governments' ability to monitor, control or shut down the communications infrastructure. The potential vulnerabilities and weaknesses associated with heavy reliance on cell phones for organizing and directing collective action movements provide lessons to potential members of government opposition as well as existing governments. Individuals or groups contemplating democratic political change may benefit from more traditional means of communication and organization, while existing governments may attempt to improve their ability to control and monitor the environment and infrastructure that enable social communication technologies.

The relatively recent advent of cell phones provides a fairly small dataset with which to assess the relationship between *Cell Phone Density*, *Political Revolution* and many other aspects of society. The role of cell phones and other social communications technologies is still evolving. The way in which societies choose to interact with and regulate these tools is also changing and in some cases taking different paths. Governments that choose to tightly monitor and control communications networks may experience drastically different results concerning the role of cell phones and other communications technologies in future political revolutions than countries that allow more freedom of use. The relative anonymity of transactions conducted through social communications technologies may allow governments or other opposition elements to infiltrate and exploit the networks of the movement. Additionally, reliance on these networks often allows governments, or those with access to the appropriate technologies, to geo-locate members and follow the activities of the collective action effort.[74] The

[74] Anita R. Gohdes, "Pulling the Plug: Network Disruption and Violence in Civil Conflict," *Journal of Peace Research* 52, no. 3 (2015): 356.

vulnerabilities presented by heavy reliance on the communications infrastructure, and the ability of government to also utilize cell phone networks to support pro-government efforts, may offer a distinct advantage to the state in the event of an uprising.

The ability of cell phones to facilitate decentralized, horizontal, grassroots coordination does not necessarily engender organizational structures that can institute effective and sustainable change. Horizontal organizations, particularly those generated by social communication technologies, are often structured along social, political and class lines. The "feeds" of those who use Twitter, Facebook or other social networking applications are often populated with news stories or updates that are posted by "friends" or by people they "follow." The information that many people receive through social communication technologies is selective in nature. In order to receive news and messages through many social networking applications, users must accept a friend request, follow an account, or be connected through other "friends." The socially, politically and economically segregated nature of social networking may only serve to facilitate interaction and coordination along exclusive horizontal lines of communication. In the event of a popular uprising or gathering in opposition to a central authority, the various groups of people who are brought together using social communication technologies may have questionable commitment to the cause or causes and significantly disparate motivations and goals. This segregation along horizontal lines of coordination and communication may inhibit the ability of these different groups to mount an effective uprising or form a consensus government following a regime overthrow.

The study consistently produces results that suggest higher levels of *Mass Media Density* will contribute to a higher probability of democratic *Political Revolution*, and a reduced likelihood of an autocratic *Political Revolution*. While this is contrary to *Hypothesis 2*, it seems that stronger communications infrastructure required for higher concentrations of mass media assets may help facilitate large-scale popular mobilization in support of democratic revolutionary movements, particularly in countries with higher levels of press freedom. This may provide all parties with valuable information concerning the potential role that mass media communications infrastructure could play in future attempts aimed at political revolution. At the same time, it may be too optimistic

to conclude that simply increasing the *Mass Media Density* within a country will increase the probability of democratic *Political Revolution*. Press freedom and access to and control of mass media networks are also important factors that were not considered in this study. When crafting themes and messages, it is also important to consider the receptivity and predisposition of the audience to messages.

It is important to exercise caution concerning the value of mass media in efforts aimed at inciting a popular revolution. For instance, some policy makers and scholars have contended that increasing the amount of foreign media and information flowing into North Korea would help instigate a popular revolution in the "Hermit Kingdom." This school of thought argues that exposing the isolated North Korean population to the outside world will highlight the deficiencies of their government and underscore the disparity of their living conditions compared to their southern neighbors. Armed with this knowledge, the argument goes, the North Korean people will rise up and demand reform. However, echoing the findings of Kern and Hainmueller,[75] by giving North Koreans a form of entertainment and something to look forward to at the end of each day, foreign media and DVDs full of South Korean television may only serve to increase contentment and reduce the probability of revolution.

The results for *Polity* provide significant predictive results that can aid policy makers in assessments of regime stability and potential for political revolution. In order to gauge the likelihood of a *Political Revolution*, the findings concerning *Polity* as displayed in Figures 8 and 9 serve as a very strong indicator of democratic or autocratic *Political Revolution*. These findings may be useful for parties interested in preventing or encouraging either autocratic or democratic *Political Revolution*. Countries with current levels of *Polity* around -4 to -2 are more likely to experience democratic *Political Revolution*, while countries with levels of *Polity* around 4 to 5 are more likely to experience autocratic *Political Revolution*.

Countries with very strong autocratic or democratic governments are less likely to experience *Political Revolution*. As an example, North Korea, which stands at a -10 on

[75] Holger Lutz Kern and Jens Hainmueller, "Opium for the Masses: How Foreign Media can Stabilize Authoritarian Regimes," *Political Analysis* 17, no. 4 (2009): 377.

the Polity IV scale is not likely to experience a democratic *Political Revolution*, and the United States, which stands at a +10, is not likely to experience an autocratic *Political Revolution*. In accordance with the results of this study, the increasing number of cell phone users in North Korea also indicate a reduced likelihood of democratic *Political Revolution.*[76] Additionally, the North Korean regime's effective control of the communications infrastructure enhances the ability of the government to monitor and control networks and interactions, further diminishing the prospect of democratic *Political Revolution*.[77]

The popular insurrections of the Arab Spring are often attributed, in large part, to the novel means of horizontal, spontaneous coordination that cell phones facilitate.[78] However, this collective action, which may often be unstructured, reactive and impersonal, may not have the robust and cohesive organizational configuration to sustain a prolonged effort designed to establish or change a government. Additionally, the cell phones that enable this coordination rely heavily on a communications infrastructure that includes cell phone towers, electric grids, internet lines and Wi-Fi points. Heavy reliance on this infrastructure creates a significant vulnerability for the movement. Authorities or other adversaries of a movement may choose to shut down this communications infrastructure, thereby severely inhibiting the ability of this opposition movement to persist.

Egypt, Tunisia, Libya, Yemen, Syria and Bahrain are examples of countries that experienced popular uprisings during the Arab Spring. When comparing the 2010 *Polity* level of the countries to the 2013 and 2015 *Polity* level of each of these six countries, only Tunisia experienced a rise on the Polity IV scale by 2015, and a change to a strong democracy (Figure 10). 2010 was chosen as a start date in order to assess the level of *Polity* within each country prior to the Arab Spring events that began in late 2010 and

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[76] Jieun Baek, *North Korea's Hidden Revolution: How the Information Underground Is Transforming a Closed Society* (New Haven & London: Yale University Press, 2016), 42.

[77] Jieun Baek, *North Korea's Hidden Revolution: How the Information Underground Is Transforming a Closed Society* (New Haven & London: Yale University Press, 2016), 43.

[78] Philip N. Howard and Muzammil M. Hussain, "What Best Explains Successful Protest Cascades? ICTs and the Fuzzy Causes of the Arab Spring," *International Studies Review* 15 (2013): 64.

continued into 2011. The absence of graphical representation, as presented in Tunisia in 2013, in Libya in 2013 and 2015 and Yemen in 2010, 2013 and 2015, denotes the absence of an existing government of any type. With the exception of Tunisia, Libya and Yemen, all countries experienced an autocratic shift, or a shift down on the Polity IV scale. Tunisia experienced a democratic shift in government type, while in Libya and Yemen, due to civil war or government transition, there was no defined government type.

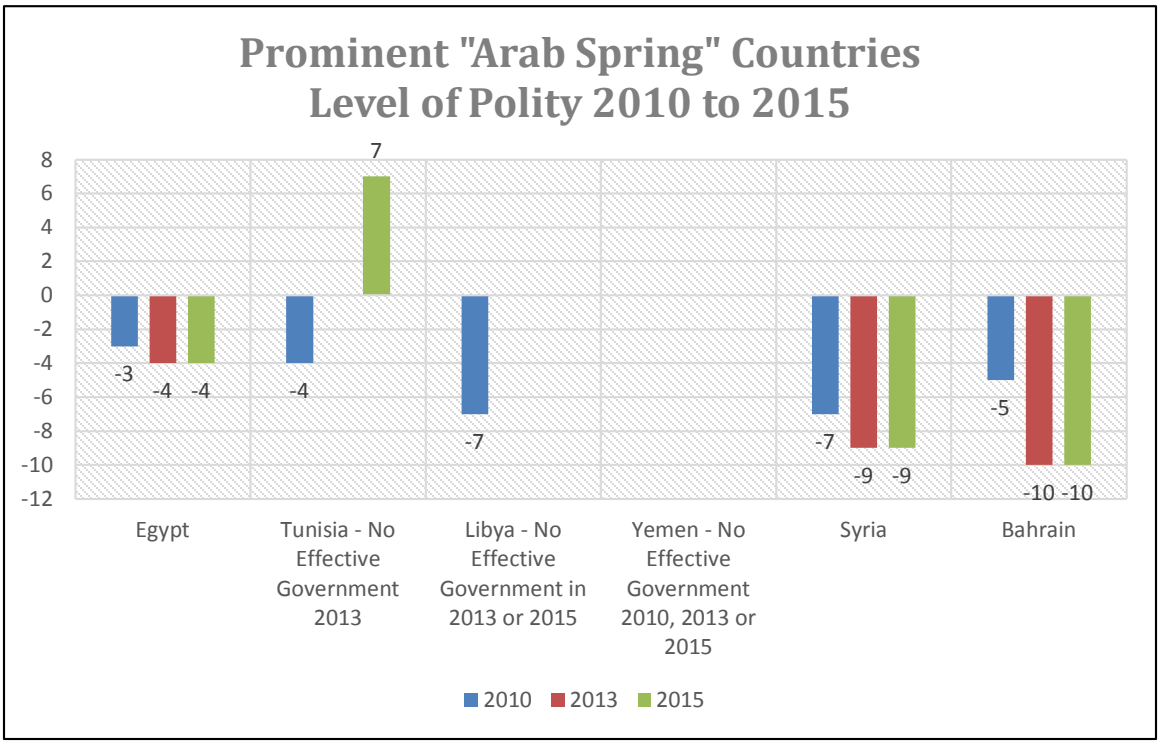

Figure 10 represents the level of *Polity* during 2010, 2013 and 2015.[79] The y-axis illustrates the *Polity* score and the x-axis illustrates the country and year. As demonstrated in the figure, only Tunisia experienced a rise on the Polity IV scale, and is considered a strong democracy.

Figure 10. Arab Spring Countries: Level of Polity 2010 to 2015

Identifying unique circumstances in Tunisia that may have contributed to the democratic *Political Revolution* may provide valuable lessons concerning the nature of successful revolutionary movements. However, as illustrated in Figure 11, in comparison

[79] "Center for Systemic Peace," The Polity Project, accessed June 09, 2017, http://www.systemicpeace.org/polityproject.html.

to other Arab Spring countries, Tunisia did not have unusual levels of the variables included in the study in the years leading up to the Arab Spring. With the exception of the level of *Polity* in Tunisia in 2010, which is in accordance with the findings illustrated in Figure 8, it does not appear that we can clearly attribute the democratic shift on the polity scale in Tunisia to any of the variables included in this analysis.

The role of the military and foreign intervention in the Arab Spring countries in response to the uprisings are topics that deserve further elaboration and may help explain the unique results in Tunisia. Out of the six Arab Spring countries examined in this study, Tunisia is the only country where domestic or foreign military forces did not intervene to suppress the protests,[80] or where the existing military was not directly involved in the formation of a new government.[81] In some cases, foreign intervention and military crackdowns succeeded in stabilizing the existing regimes, while in other cases foreign intervention succeeded in toppling existing regimes. However, in every country where the military was involved in suppression or reestablishing governance, the state remains without an effective government or the level of *Polity* became more autocratic.

[80] Lisa Anderson, "Demystifying the Arab Spring: Parsing the Differences Between Tunisia, Egypt, and Libya," *Foreign Affairs* 90, no. 3 (2011): 3.

[81] Frederic Volpi, "Explaining (and re-explaining) Political Change in the Middle East During the Arab Spring: Trajectories of Democratization and of Authoritarianism in the Maghreb," *Democratization* 20, no. 6 (2013): 979.

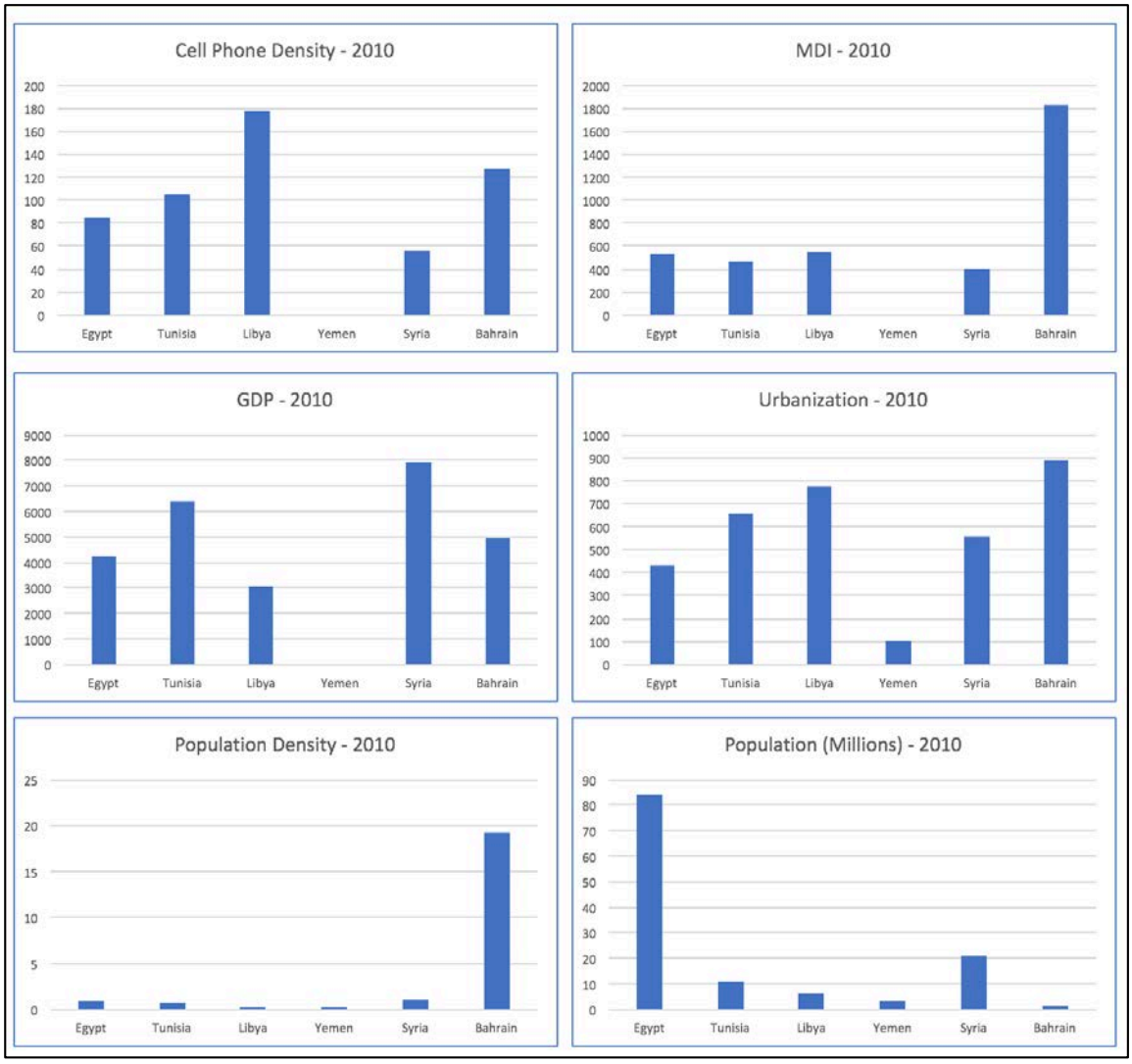

Figure 11 represents the level of the variables in the study in 2010 for Arab Spring countries.

Figure 11. Arab Spring Countries: Level of Variables in the Study

V. RECOMMENDATIONS TO IMPROVE FUTURE STUDIES

To better understand the relationship between communication technologies use and political revolution, future studies should focus on governments' ability to use cell phones and social communication technologies for population control and suppression and also assess the strengths and weaknesses of organizations and networks enabled by cell phones. Additionally, subsequent studies should attempt to identify the reasons for the success of the Tunisian democratic political revolution versus the failure of other Arab Spring revolutions to achieve democracy.

Conducting a more thorough analysis of the conditions in Tunisia is required to more reliably identify the factors that contributed to democratic political revolutions. Some specific areas that may benefit from further research include the role and level of foreign intervention, domestic government and military dynamics, and the specific tactics used by government and opposition forces in the attempt to suppress dissent or reform government. Additionally, identifying the grievances of the opposition is important to understand the ultimate goals of the movement and may help to explain the different results of the Arab Spring uprisings.

Evaluating the ownership and control of internet servers, cell towers, electric grids and other infrastructure that enable modern communications technologies may aid future analyses wishing to assess the potential impact of cell phones and other information and media technologies on various aspects of society. Additionally, it is important to consider the existing security, both physical and cyber, of the communications infrastructure. Furthermore, in order to more accurately evaluate how cell phones influence the generation of political revolutions, future studies should incorporate a measurement of freedom of the press and evaluate existing laws concerning government control of, or interference with, the communications infrastructure within each country. Evaluating press freedom and the ability or willingness of government to control communications infrastructure can help gauge the level of accessibility to the production of media content and also measure the ability of non-government entities to

propagate ideas, access content and communicate using cell phone, social communication technology, and mass media networks.

This study also reveals significant findings concerning the predictive value of *Polity* in relation to the probability of *Political Revolution*. In future studies seeking to identify governments at risk of revolution, using the level of *Polity* as a predictor of revolution may help narrow down the field of countries in the examination and allow for a more thorough investigation. Additionally, future studies may benefit from assessing the potential role that cell phones and social communication technologies may play in economic development, and an increase in per capita *GDP*. This may help identify ways to use these tools to help improve not only individual living conditions, but also increase the stability of existing democracies.

Future studies should also consider the rapid pace at which cell phone and social communication technology is advancing. As smart phone use continues to increase, and as various sectors of society use these technologies for an increasing number and variety of transactions, their role may continue to evolve and present different results concerning the causes of political revolution than witnessed in this study. The increasing reliance on cell phones, communications technologies and computer networks to perform many daily tasks throughout society, such as financial transactions and records management, creates a possible vulnerability that if exploited by nefarious factions, may lead to widespread civil strife and serve as a catalyst for rapid political shifts.

Future revolutions may occur as a result of hitherto unparalleled and unanticipated actions. It is important to consider the lessons that recent revolutions involving cell phones and other social communication technologies provide to all parties. Those wishing to suppress opposition and those seeking to reform existing government will learn from previous successes and failures. All parties have the ability to alter their approach in response to future revolutionary activities, which may produce unexpected tactics and results. The results of this study may help policy makers identify potential trouble spots and prepare for the possibility and consequences of future political transformations.

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