A Network-Based Model of Resource Shocks, Regime Transitions, and Robustness

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Abstract

This paper explores regime transitions under resource shocks with a network-based agent-based model to find the endogenous characteristics that make political structures robust. The first section tries to define the phrases "regime transitions" and "resource shocks" in a general yet precise fashion. The second section poses the question of how to construct robust political regimes, and discusses the theoretical and policy significance of solving this puzzle. The third section surveys existing theories of regime transitions, including Fukuyama's "inevitabilism," modernization theory, authoritarian stability, and the civil society approach. The fourth section introduces and methodologically justifies the modeling tools used in this paper, i.e. network analysis, agent-based modeling, and computer simulation. The fifth section presents the model specification, explaining each design choice in its mathematical formality and social scientific purpose. The sixth section displays results from simulations on three different network topologies and hypothesizes that regimes with high capacity, low centralization, and high connectivity will be most stable and prosperous. The seventh section outlines future work in the form of larger model parameter sweeps, incorporation of other social scientific ABM modules, and rigorous quantitative and qualitative empirical testing. The paper concludes with a provocative suggestion that "democracy" has outlived its usefulness for characterizing regimes.

Definitions

In order to build a well-specified model of *regime transitions* under *resource shocks*, we must outline what each of those phrases entails conceptually.

A regime, in its simplest form, outlines the rules of the game. As Gerardo Munck clarifies, regimes are "the procedural rules that determine: 1) The number and type of actors who are allowed to gain access to the principal governmental positions; 2) the methods of access to such positions, and; 3) the rules that are followed in the making of publicly binding decisions."[1] This classic, strictly formal definition allows us to separate regime from the related concepts, state and government (see Figure 1).[2] However, as Barbara Geddes points out, "informal rules… that shape and constrain [political actors'] choices" must also be included in any good definition of a regime.[3] Keeping this in mind, T.J. Pempel argues that a regime consists of alliances, institutions, and public policy.[4] Though these are constantly shifting, we can evaluate regimes and whether they transition by looking at two parameters -- state capacity and participation, or informally, "sticks and carrots."[5] When either of these parameters undergoes a qualitative change,[6] e.g. the state loses a significant amount of power relative to non-state actors, or the regime democratizes, we can call this a regime transition.

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[1] Gerardo L. Munck, "Disaggregating Political Regime: Conceptual Issues in the Study of Democratization," Helen Kellogg Institute for International Studies Working Paper #228 (Rochester, NY: Social Science Research Network, August 14, 1996), 6.

[2] Sally N. Cummings et al., "State, Regime, and Government in the Kyrgyz Republic (1991–2010): Disaggregating a Relationship," *East European Politics* 29, no. 4 (December 1, 2013): 443–60.

[3] Barbara Geddes, Joseph Wright, and Erica Frantz, "Autocratic Breakdown and Regime Transitions: A New Data Set," *Perspectives on Politics* 12, no. 2 (June 2014), 314.

[4] T. J. Pempel, ed., "Patterns of Political Economy: A Range of Regimes," in *Regime Shift, Comparative Dynamics of the Japanese Political Economy* (Cornell University Press, 1998), 20.

[5] Mary Gallagher and Jonathan K. Hanson, "Coalitions, Carrots, and Sticks: Economic Inequality and Authoritarian States," *PS: Political Science and Politics* 42, no. 4 (2009), 668.

[6] Though the literature on tipping points and phase transitions largely comes from statistical mechanics, for an application of this concept to social systems, see Moshe Levy, "Social Phase Transitions," *Journal of Economic Behavior & Organization* 57, no. 1 (May 1, 2005): 71–87.

While the typology may be crude, this is common in the literature[7] because it gives us a simple, stylized representation of a rather complex concept (see Figure 2).

Figure 1: A stylized distinction between state, regime, and government

Figure 2	**Low Participation**	**High Participation**
Low Capacity	Weak dictatorship (Zimbabwe)	Weak democracy (Haiti)
High Capacity	Strong dictatorship (Saudi Arabia)	Strong democracy (Germany)

Resources, as used here, simply signifies those goods necessary for living that can be distributed and accumulated. This definition is simultaneously broad and narrow; whereas this is broader than the natural resources (e.g. oil, minerals, timber) that political scientists often discuss, it is also narrower than the all-encompassing sense in which sociologists include health, cultural capital, and personal development.[8] Given this basic definition, our

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[7] Charles Tilly, *The Politics of Collective Violence* (Cambridge University Press, 2003), 47-48.
[8] Tony Fitzpatrick, ed., *Climate Change and Poverty*: *A New Agenda for Developed Nations* (Policy Press at the University of Bristol, 2014), 38.

notion of resource *shock* is similar to the one for *transition*, since these both involve tipping points. To give some concrete examples, shocks from the literature can include events as varied as commodity price fluctuation,[9] macroeconomic financial shocks,[10] and even environmental stresses like drought.[11] With these bare-bones definitions, we can try to formulate a series of questions regarding regime transitions under resource shock.

Conditions, Characteristics, and Construction

A good theory of regime transitions answers three key questions:

1. Under what conditions do regimes transition?
2. What endogenous characteristics of the regime make it likely to transition, and given those traits, what are the transition probabilities?
3. How do we construct more robust political systems?

These questions hold enormous implications both for theory and practice. First, knowing the transition probabilities for different regimes is inherently valuable for predictive purposes. Second, knowing the causal mechanisms behind these transition probabilities would be even more helpful. Theoretically, explaining the transition probabilities could uncover details about the tendencies of different political structures and allow for better qualitative process-tracing.[12] Third, identifying the source of robustness would not only give us theoretical insight into political structure, but also provide practical advice for policymakers. Since economic shocks may be more common in the near future due to climate

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[9] Oeindrila Dube and Juan F. Vargas, "Commodity Price Shocks and Civil Conflict: Evidence from Colombia," *The Review of Economic Studies* 80, no. 4 (285) (2013): 1384–1421.

[10] Charles L. Evans and David A. Marshall, "Fundamental Economic Shocks and the Macroeconomy," Journal of Money, Credit and Banking 41, no. 8 (2009): 1515–55.

[11] Edward Miguel and Shanker Satyanath, "Re-Examining Economic Shocks and Civil Conflict," *American Economic Journal: Applied Economics* 3, no. 4 (2011): 228–32.

[12] David Collier, "Understanding Process Tracing," PS: Political Science and Politics 44, no. 4 (2011): 823–30.

change-related stressors[13] and increasing financial market volatility[14], it will be imperative to create more robust political systems. This study will largely concern itself with the last two questions, because we limit our scope to those transitions that happen as a result of resource shocks (rather than, for example, international diffusion[15]).

Though some scholars have challenged the study of regime transitions ("transitology"), their critiques are not well-founded. Some, like Steven Holmes, have gone so far as to say that "the overused term 'transition' should probably be junked, implying that… we somehow know where we are headed."[16] Mira Marody adds that "it does not necessarily have to be a simple route from one well-known system to another."[17] Howard Wiarda similarly argues that transitology presumes "rigid and static categories" that do not consider path-dependent reforms in the old regime.[18] These are, of course, straw-man arguments. The study of regime transitions need not presume some kind of inevitable historical determinism nor shoehorn societies[19] into discrete categories defined by "well-known systems." While some transitologists do make these errors, that does not render the concept of transition devoid of meaning. Our construction of the question, which focuses on the endogenous characteristics of a regime, exactly addresses Wiarda's concern. Others,

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[13] J.R. Porter, L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso, *Food Security and Food Production Systems*, report, found in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, (Cambridge: Cambridge University Press, 2014), 512.
[14] M. Ayhan Kose, Eswar S. Prasad, and Marco E. Terrones, "Financial Integration and Macroeconomic Volatility," IMF Staff Papers 50 (2003): 119–42. Note that volatility has only increased for developing countries, where macroeconomic globalization has led to much larger financial flows and specialization.
[15] Kristian Skrede Gleditsch and Michael D. Ward, "Diffusion and the International Context of Democratization," International Organization 60, no. 4 (2006): 911–33.
[16] Steven Holmes, "Probing the Postcommunist Dilemma," in Michael Mandelbaum, *Postcommunism: Four Perspectives* (Council on Foreign Relations, 1996), 22.
[17] Mira Marody, "Post-Transitology or Is There Any Life After Transition?," Polish Sociological Review, no. 117 (1997), 15.
[18] Howard J. Wiarda, "Southern Europe, Eastern Europe, and Comparative Politics: 'Transitology' and the Need for New Theory," East European Politics and Societies 15, no. 3 (September 1, 2001), 486.
[19] For a complaint about how transitologists characterized a number of complex societies "on their way to democracy" in the 1990s, Vedi R. Hadiz, "Understanding Social Trajectories: Structure and Actor in the Democratization Debate," Pacific Affairs 81, no. 4 (2008), 531.

like Valerie Bunce, have argued against comparing democratic transitions in Latin America to post-communism in Eastern Europe, where diffusion and international context mattered significantly.[20] This critique is more serious, but our framework can simply include international context in the *exogenous* shock conditions, which vary in their impact due to *endogenous* regime characteristics.

A Survey of Regime Transition Theories

In order to build a theoretical framework, we can first survey four different approaches to explaining regime transitions: The inevitabilist approach, modernization theory, authoritarian stability, and the civil society approach. For each of the four approaches, we can answer the three questions posed above and offer a cursory theoretical and empirical evaluation. These approaches cover most ground in the "transitology" and "consolidology" literature, though there is a notable omission of the literature on democratic failure. Not only are there few existing paradigms that can explain it,[21] but also, there are few empirical cases of the phenomenon.[22] Therefore, we will primarily aim to explain democratization and stable autocracies.

Inevitabilists

Inevitabilism, the approach most prominent in policy and most criticized in academia, holds that all regimes will inevitably become liberal democracies. Francis Fukuyama, the

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[20] Valerie Bunce, "Should Transitologists Be Grounded?," Slavic Review 54, no. 1 (1995), 120.

[21] Abraham Diskin, Hanna Diskin, and Reuven Y. Hazan, "Why Democracies Collapse: The Reasons for Democratic Failure and Success," International Political Science Review / Revue Internationale de Science Politique 26, no. 3 (2005), 291.

[22] Ibid, 296. In Diskin et. al.'s study, they only identify 30 cases of democratic collapse over an 80-year period of analysis. Moreover, a number of cases they include are what might be called non-consolidated democracies.

most notable proponent of this theory, speculated in 1989 that "what we may be witnessing is… the end of history… that is, the end point of mankind's ideological evolution and the universalization of Western liberal democracy as the final form of human government."[23] Fukuyama borrows from Alexander Kojeve and argues that this inevitable drive towards liberal democracy is driven by ideology.[24] The *conditions* that favor regime transitions to democracy are simply the lack of ideological alternatives like communism. Moreover, where democracy has not been consolidated, the key *characteristics* preventing its adoption have to do with a lack of education and ignorance.[25] Although inevitabilists have disagreed about the extent to which the US should engage in militarized democracy promotion, they generally agree that existing liberal democracies must help *construct* market democracy in order to promote global security.[26] While democracy may be inevitable, on this account, it would be best if the process was accelerated by democratic states.

Inevitabilism has been thoroughly deconstructed by a number of scholars, so this study will only offer a brief overview. Inevitabilist theories about the conditions under which democracy can happen have gaping conceptual and empirical holes. In the late 1800s, Alexis de Tocqueville made the same arguments when monarchy had collapsed,[27] yet societies found alternatives to liberal democracy. Even contemporary scholars have made the mistake of simply analyzing successful democratic transitions, rather than considering cases of authoritarian stability (i.e. variations on the dependent variable).[28] Inevitabilists have not

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[23] Francis Fukuyama, "The End of History?," The National Interest, no. 16 (1989), 4.
[24] James W. Ceaser, *Reconstructing America: The Symbol of America in Modern Thought* (Yale University Press, 1997), 217.
[25] Jerry E. Pournelle, "The Future of Democracy," International Journal on World Peace 11, no. 1 (1994), 22.
[26] Michele Acuto, "Wilson Victorious? Understanding Democracy Promotion in the Midst of a 'Backlash,'" Alternatives: Global, Local, Political 33, no. 4 (2008), 465.
[27] Denis W. Brogan, "The Prospects for Democracy," in *Dictatorship in the Modern World*, (University of Minnesota Press, 1939), 310.
[28] Darren Hawkins, "Democratization Theory and Nontransitions: Insights from Cuba," Comparative Politics 33, no. 4 (2001), 441.

analyzed the causes of ideological competition, and therefore, have been accused of ignoring the systemic issues of poverty, inequality, and corruption in liberal democracies.[29] Consequently, in their discussion of characteristics preventing democracy, inevitabilists' accounts are paternalistic and orientalist; on their view, societies searching for alternative systems are simply "not [be] ready for market democracy."[30] Finally, their prescriptions about promoting democracy have been criticized not only for being missionaristic and cult-like, but also for being grossly ineffective at producing better outcomes.[31] Clearly, a good model of regime transitions requires more nuance than inevitabilists have to offer.

Modernization Theory

Modernization theories have been most influential for explaining regime transitions for much of the 20th century scholarship. As Seymour M. Lipset plainly puts it, "the more well-to-do a nation, the greater the chances that it will sustain democracy."[32] Lipset justifies this reasoning by claiming that economic development is necessary *condition* for a citizenry that "could intelligently participate in politics."[33] The *characteristic* most key for a democratic transition, on this view, is the presence of economic elites who accrue wealth and strength vis-a-vis the state.[34] Because these elites weaken the state's monopoly on productive

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[29] Carlos Fuentes, "The End of Ideologies?," Transition, no. 51 (1991), 30.

[30] Antonina W. Bouis, "Western Protectors," in *Lonely Power: Why Russia Has Failed to Become the West and the West Is Weary of Russia* (Carnegie Endowment for International Peace, 2010), 191. As Bouis also notes, the anti-democratic drift in Russia has actually happened side-by-side with capitalist development, yet inevitabilists do not consider that their prescriptions may be failing due to internal incoherencies.

[31] Arthur A. Goldsmith, "Making the World Safe for Partial Democracy? Questioning the Premises of Democracy Promotion," International Security 33, no. 2 (2008), 124. For a detailed critique of democracy promotion due to the dangers of partial democratization, see Jack L. Snyder and Professor Jack L. Snyder, *From Voting to Violence: Democratization and Nationalist Conflict* (Norton, 2000). For a more cynical critique about the use of democracy promotion to further hegemonic interests, see William I. Robinson, *Promoting Polyarchy: Globalization, US Intervention, and Hegemony* (Cambridge University Press, 1996).

[32] Seymour Martin Lipset, "Some Social Requisites of Democracy: Economic Development and Political Legitimacy," The American Political Science Review 53, no. 1 (1959), 75.

[33] Lipset, "Some Social Requisites of Democracy," (1959), 75.

[34] Barbara Geddes, "What Causes Democratization," The Oxford Handbook of Political Science, July 7 2011.

capacity, the state must bargain with them and offer concessions. Empirically, we can point

to the correlation between rising middle-class income and democratization as proof of this

mechanism.[35] Consequently, for modernization theorists, building more robust and effective

political structures involves *constructing* institutions more conducive to broad-based

economic growth.[36] In the typology suggested by Herbert Kitschelt, this theory is largely

structural, pointing to some cluster of economic variables as the primary determinant for

democratization.[37]

      Modernization theory, while more rich than inevitabilism, also has fundamental flaws.

Methodologically, its broad connection between economic development and democracy does

not offer clear implications of what would constitute good evidence, allowing researchers to

cherry-pick the variables that do support the hypothesis.[38] As Dean Tipps puts it, "the concept

of modernization not only lacks a precise cutting-edge because of the vagueness with which it

is defined, but many of the assumptions built into it concerning the nature of its empirical

referents also turn out, upon further examination, to be false or misleading."[39] Rather than

conceptually clarifying the relation between structural variables, "modernization becomes

little more than a classificatory device distinguishing processes of social change… heavily

laden with ethnocentric bias."[40] Samuel Huntington, on the other hand, takes issue with the

modernization school's assumption that economic development and state weakening must

necessarily lead to democratization, since modernization can actually destabilize societies.[41]

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[35] Robert J. Barro, "Determinants of Democracy," Journal of Political Economy 107, no. S6 (1999): S158–83.

[36] Daron Acemoglu and James A. Robinson, "De Facto Political Power and Institutional Persistence," The American Economic Review 96, no. 2 (2006), 330.

[37] Herbert Kitschelt, "Political Regime Change: Structure and Process-Driven Explanations?," ed. Paul Brooker et al., The American Political Science Review 86, no. 4 (1992), 1034.

[38] Darren Hawkins, "Democratization Theory and Nontransitions," 442.

[39] Dean C. Tipps, "Modernization Theory and the Comparative Study of Societies: A Critical Perspective," Comparative Studies in Society and History 15, no. 2 (1973), 222.

[40] Dean Tipps, "Modernization Theory" (1973), 222.

[41] Samuel Huntington, *Political Order in Changing Societies*, (New Haven, CT: Yale Univ Press, 1968).

For Huntington, the *response to* modernization affects outcomes. For rentier state theorists like Lisa Anderson, the *form of* modernization affects outcomes, since resource wealth allows authoritarian states to buy compliance.[42] Finally, promoting economic growth may actually have adverse distributional impacts and hamper democratic development,[43] so it is unclear whether the prescription modernization theory provides is even coherent.

Authoritarian Stability

Rather than focusing on structural variables like modernization theory, authoritarian stability focuses on the process by which undemocratic governments can maintain control. The two *conditions* that allow for authoritarian stability are repression and cooptation (sticks and carrots). As Edward Mason argued in 1978, the wave of democracy that should have theoretically accompanied modernization was prevented by violent repression and control over the flow of information.[44] Cooptation, according to theorists of authoritarian stability consists primarily of economic and political patronage; while this may be oil rents in resource-rich states, it could also be political promises made to potential competitors.[45] Thus, the *characteristics* that make regimes stable for these theorists have to do with the capacity to generate repression and patronage. For example, authoritarian stability can be promoted by faux elections, which appease competitors without compromising the state's monopoly over violence.[46] For these theorists, *constructing* more robust (though not necessarily more

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[42] Lisa Anderson, "The State in the Middle East and North Africa," Comparative Politics 20, no. 1 (1987), 10.

[43] Atul Kohli, "Politics of Economic Growth in India, 1980-2005: Part I: The 1980s," Economic and Political Weekly 41, no. 13 (2006), 1251.

[44] Edward S Mason, "Authoritarian Development," Educational Horizons 57, no. 1 (1978), 27.

[45] Joseph Wright and Abel Escriba-Folch, "Authoritarian Institutions and Regime Survival: Transitions to Democracy and Subsequent Autocracy," British Journal of Political Science 42, no. 2 (2012), 286.

[46] Ruchan Kaya and Michael Bernhard, "Are Elections Mechanisms of Authoritarian Stability or Democratization? Evidence from Postcommunist Eurasia," Perspectives on Politics 11, no. 3 (2013), 734. Empirically, this relationship holds in a number of regions, even though Kaya and Bernhard largely focus on Eastern Europe. For a broader application of this thesis, see Carl Henrik Knutsen, Håvard Mokleiv

desirable) political systems need not involve democratization or modernization at all, as long as violence and patronage can keep dissent in check.

Like modernization theory, authoritarian stability has been criticized for providing faulty mechanistic explanations even when making accurate empirical predictions.[47] According to Levitsky and Way, while patronage may allow for cooptation in normal circumstances, durability under duress requires other mechanisms for elite cohesion, such as previous violent experience.[48] Moreover, patronage can sometimes lead to expectations that produce collective discontent and instability; as Jay Ulfelder puts it, "the absence of any social contract linking the despot's right to rule to the… well-being of the people reduces the impact of mass challenges to the regime on regime stability."[49] In these contexts, popular movements must resort to violent struggles and regimes with repressive capacity can maintain control. However, some scholars challenge this mechanism of authoritarian stability as well, since repression often requires a military that has empirically developed its own interests as an autonomous actor, such as during the Arab Spring.[50] Finally, power-sharing may increase stability because it helps regimes monitor potential challengers, not because of cooptation.[51] This insight is consistent with the observed pattern that semi-democracies are

Nygård, and Tore Wig, "Autocratic Elections: Stabilizing Tool or Force for Change?," *World Politics* 69, no. 1 (January 10, 2017): 98–143.

[47] Benjamin Smith, "Oil Wealth and Regime Survival in the Developing World, 1960-1999," American Journal of Political Science 48, no. 2 (2004): 232–46. While oil states are a subset of authoritarian states with potentially distinct properties, the use of repression and patronage has been directly empirically linked to greater stability, evaluated with metrics including regime duration, incidents of protests, etc.

[48] Steven R. Levitsky and Lucan A. Way, "Beyond Patronage: Violent Struggle, Ruling Party Cohesion, and Authoritarian Durability," Perspectives on Politics 10, no. 4 (2012), 870.

[49] Jay Ulfelder, "Contentious Collective Action and the Breakdown of Authoritarian Regimes," International Political Science Review / Revue Internationale de Science Politique 26, no. 3 (2005), 316.

[50] F. Gregory Gause, "Why Middle East Studies Missed the Arab Spring: The Myth of Authoritarian Stability," Foreign Affairs 90, no. 4 (2011), 84-86.

[51] Carles Boix and Milan W. Svolik, "The Foundations of Limited Authoritarian Government: Institutions, Commitment, and Power-Sharing in Dictatorships," The Journal of Politics 75, no. 2 (2013), 300-301.

more unstable than both democracies and autocracies.[52] However, this critique can likely be reconciled with authoritarian stability with more precise definitions of "democracy" and more details about what constitutes power-sharing and faux participation. Although authoritarian stability may make less predictive errors than modernization theorists, its process-oriented theses require more mechanistic specificity.

Civil Society Approach

The civil society approach is the youngest in the literature, allowing it to synthesize and complement a number of older theories in its analysis. The *conditions* that allow for democratization are a robust civil society, which has been defined by Larry Diamond as "citizens acting collectively in a public sphere to express their interests [in a way] that is open, voluntary… and autonomous from the state."[53] To put the theory more precisely, when the state has weakened vis-a-vis civil society groups, regimes are expected to democratize due to "conflict and compromise between the increasingly organized [civil society] and the ruling part[ies]."[54] While the civil society approach does not exclusively or even largely focus on business groups, this thesis is largely consistent with modernization theory, which centers non-state economic elites. Although the focus on conflict and compromise may make this theory seem process-oriented, the *characteristics* that it identifies as helping democratic transitions are largely structural. For these theorists, when civil society has more resources (economic, political, or social), independently from state patronage and access, there are higher chances of a democratic transition.[55] Naturally then, this theory advises policymakers

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[52] Carl Henrik Knutsen and Håvard Mokleiv Nygård, "Institutional Characteristics and Regime Survival: Why Are Semi-Democracies Less Durable Than Autocracies and Democracies?," American Journal of Political Science 59, no. 3 (2015), 658.
[53] Larry Diamond, *Developing Democracy: Toward Consolidation* (JHU Press, 1999), 221.
[54] Sunhyuk Kim, *The Politics Of Democratization In Korea* (University of Pittsburgh Press, 2000), 9.
[55] Laurel E. Miller et al., eds., "Lessons from Past Transitions and Policy Implications," in *Democratization in the Arab World, Prospects and Lessons from Around the Globe* (RAND Corporation, 2012), 305.

to *construct* more robust polities by giving aid to non-governmental civil society organizations,[56] an approach that has become increasingly popular since the 1990s.

Even as the civil society approach has made a number of conceptual advances, it is still far from a mature theory. Empirically, the approach has several advantages. First, a robust civil society has been linked to multiple stages of political development, including authoritarian regression, democratic transition, and democratic consolidation.[57] Second, as the theory would predict, structural factors (such as urbanization) that strengthen civil society networks are strongly correlated with democratization.[58] On the flip-side personalistic regimes that cause institutional vacuums outside the state have been empirically less likely to democratize.[59] Furthermore, the most notable case of autocratic stability, China, has seen civil society consciously and systematically stifled.[60] Third, authoritarian regimes have shown to re-centralize when a nominal democratic transition does not succeed in shifting the distribution of capacity away from the state towards civil society.[61] However, upon closer analysis, the civil society approach becomes much less tenable. As E. Remi Aiyede argues from the case of Nigeria, civil society groups are rarely independent from the state, and as such, can be divorced from the vast majority of the public.[62] Partially, the problem stems from unclear, hollow language; as Neera Chandhoke astutely notes,

> "If civil society is hailed by almost everyone, from trade unions, social movements, the United
> Nations, the International Monetary Fund, the World Bank, NGOs, lending agencies, and
> borrowing agencies to states - both chauvinistic and democratic - as the ideal elixir to counter
> the ills of the contemporary world, there must be something wrong… The emergence on our

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[56] Marina Ottaway and Thomas Carothers, *Funding Virtue: Civil Society Aid and Democracy Promotion* (Carnegie Endowment for International Peace, 2000), 294.

[57] Sun-Hyuk Kim, *The Politics Of Democratization In Korea* (University of Pittsburgh Press, 2000), 19.

[58] Jeremy Wallace, "Cities, Redistribution, and Authoritarian Regime Survival," The Journal of Politics 75, no. 3 (2013), 632.

[59] Barbara Geddes et. al., "Autocratic Breakdown and Regime Transitions," 326.

[60] Tianjian Shi, *How East Asians View Democracy* (Columbia University Press, 2008), 211.

[61] Claudio Véliz, *The Centralist Tradition of Latin America* (Princeton University Press, 1980), 280-281.

[62] E. Remi Aiyede, "The Dynamics of Civil Society and the Democratization Process in Nigeria," Canadian Journal of African Studies / Revue Canadienne Des Études Africaines 37, no. 1 (2003), 3.

theoretical horizon of a truncated, flattened out, jaded avatar of civil society, stripped of all contradictions and tensions, may justifiably give us cause for thought."[63]

By defining civil society amorphously, the approach can flexibly incorporate more insights post-hoc, without providing any predictive or explanatory power. If our conception of civil society includes business elites that may cooperate with the state, or NGOs that recruit solely from technocratic professional ranks,[64] then it may not be an engine of democratization. Therefore, while the relative power distribution between civil society and the state may be important, the theory has yet to specify the ways in which *specific* civil society actors can leverage their resources toward democratization.

Modeling Toolbox: Networks, Agents, and Simulation

The tools we have available to us shape the scope of the theories that we construct, even though traditional notions of research place theory prior to empirical testing.[65] The departure that this study takes from traditional transitology -- by conceptualizing regime transitions more generally than democratization or modernization -- is supported by a toolbox more capable of generalization. I will offer a brief introduction to each tool, with a justification for its use in international relations and political science research.

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[63] Neera Chandhoke, "Civil Society," Development in Practice 17, no. 4/5 (2007), 609.

[64] Marina Ottaway et. al., *Funding Virtue*, 295.

[65] Robert K. Merton, "The Bearing of Empirical Research upon the Development of Social Theory," American Sociological Review 13, no. 5 (1948), 506. As Merton rightly notes, scientific theory has traditionally been conceptualized as a "hunch" from some examples that then requires further empirical testing. However, both empirical cases and methods impact the process of theory-building.

Network Analysis

Network science concerns itself with the behavior of distinct actors or elements, i.e. *nodes*, connected by *links* or *edges*. Network analysis serves as a useful tool for a variety of abstract problems, such as characterizing network shapes or topologies ("what effectively summarizes a network"),[66] link prediction ("who will connect with whom"),[67] and diffusion of content ("how do you ensure that information reaches the whole network").[68] The ability to make accurate predictions simply based on network shapes and the rules for its evolution[69] allow us to identify *the characteristics that make* structures *deterministic*, rather than assuming that *all* structures necessarily are.[70] Finally, networks offer granular specificity and abstract generality simultaneously; whereas agents' actions and relational characteristics can be specified given some domain-specific cultural-historical knowledge, abstract results of network structure and dynamics can still be applicable.[71]

Although network science has only rarely been applied to international relations thus far,[72] the mapping between the two fields is straightforward and natural. Where network science refers to topology, i.e. who's connected to whom, and rules of evolution, political

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[66] Raúl J. Mondragón, "Topological Modelling of Large Networks," *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 366, no. 1872 (2008): 1931–40.

[67] C. J. Rhodes and P. Jones, "Inferring Missing Links in Partially Observed Social Networks," *The Journal of the Operational Research Society* 60, no. 10 (2009): 1373–83.

[68] Matt J Keeling and Ken T.D Eames, "Networks and Epidemic Models," *Journal of the Royal Society Interface* 2, no. 4 (September 22, 2005): 295–307, https://doi.org/10.1098/rsif.2005.0051.

[69] Elizabeth Mowat, "Making Connections: Mathematical Understanding and Network Theory," For the Learning of Mathematics 28, no. 3 (2008), 22.

[70] Alexander E. Wendt, "The Agent-Structure Problem in International Relations Theory," *International Organization* 41, no. 3 (ed 1987): 335–70. The agent-structure problem has persisted in the social sciences, though network science offers predictions that resolve it in an intuitive fashion; some outcomes are predictable (informally by humans or computationally) given structural information, whereas others are not. Those other cases are likely sensitive to our specification of agents' decision-making rules.

[71] Stephen P. Borgatti and Daniel S. Halgin, "On Network Theory," Organization Science 22, no. 5 (2011), 1176.

[72] Emilie M. Hafner-Burton, Miles Kahler, and Alexander H. Montgomery, "Network Analysis for International Relations," International Organization 63, no. 3 (2009): 559–92. While there has been discussion about networks more broadly in international relations research, this paper is the only one I'm aware of that ties in abstract network science results to domain-specific problems.

science speaks of *regimes*. Regime attributes are closely proxied by network shapes, and the quantifiability of networks may allow us to answer questions about, for example, why some democracies are "hybrid," "illiberal," or "incomplete."[73] Similarly, where network science speaks of link formation, i.e. making new connections, political science theorizes about clientelism and patronage. Link formation gives us a convenient tool to analyze resources traveling over a political network as alliances and patron-client relations shift.

Agent-Based Modeling

The primary purpose of agent-based modeling (ABM) is to uncover how local interactions between rule-abiding agents leads to global effects. Rather than trying to design the most optimal agents,[74] ABM gives insight into the expected outcomes of interacting agents with certain characteristics and environmental constraints. Not only does ABM allow us to explicitly model heterogeneous actors,[75] but it also gives actors the ability to learn and co-evolve given signals from the environment.[76] By combining ABM with network analysis, we can simultaneously model more large-scale phenomena and break down the black boxes of individual-level behavior.[77]

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[73] Andrea Cassani, "Hybrid What? Partial Consensus and Persistent Divergences in the Analysis of Hybrid Regimes," International Political Science Review / Revue Internationale de Science Politique 35, no. 5 (2014), 542. As Cassani notes, talks of "hybrid" democracies have been unclear about what regime parameters exactly are being mixed together. Joakim Ekman argues for measuring participation and access to power rather than electoral outcomes, which strongly connects back to notions of network topology. Joakim Ekman, "Political Participation and Regime Stability: A Framework for Analyzing Hybrid Regimes," International Political Science Review / Revue Internationale de Science Politique 30, no. 1 (2009), 8.

[74] Muaz Niazi and Amir Hussain, "Agent-Based Computing from Multi-Agent Systems to Agent-Based Models: A Visual Survey," Scientometrics 89, no. 2 (November 1, 2011), 479.

[75] Neoclassical economics most notably suffers from this modeling flaw, since preference aggregation of heterogeneous agents does not lend itself to the standard equilibrium analysis. For a proof, see Tommaso Gabrieli and Sayantan Ghosal, "Non-Existence of Competitive Equilibria with Dynamically Inconsistent Preferences," Economic Theory 52, no. 1 (2013): 299–313.

[76] Ross A. Hammond, *Considerations and Best Practices in Agent-Based Modeling to Inform Policy,* (National Academies Press (US), 2015), https://www.ncbi.nlm.nih.gov/books/NBK305917/, 1-3.

[77] Magda Fontana and Pietro Terna, "From Agent-Based Models to Network Analysis (and Return): The Policy-Making Perspective," Department of Economics and Statistics, Cognetti de Martiis, Working Papers (University of Turin, January 2015).

ABM provides a rich yet compact representation for international relations research where other methods do not. First, like with network analysis, ABM does not presume any naive agent-structure dichotomy; agents act within constraints of the environment and their learned rules, yet they also shape their environment. At the same time, its rich representation is unlike the "thick description"[78] used in social sciences because it can be summed up in a compact and generalizable schema. Second, unlike game theory,[79] ABM assumes that agents act in a bounded-rational manner with *locally perfect* information rather than *globally perfect or globally imperfect* information.[80] Finally, ABM simulations provide a natural model of feedback loops, which are common to complex political systems[81] but difficult to analyze via traditional statistical regression.[82] In comparison to other modeling techniques used in political science, ABM is much more expressive without losing mathematical or definitional rigor.

Computational Modeling

Computational modeling, as opposed to traditional formal or mathematical modeling, provides yet another important new tool for international relations research. As philosopher of science Thomas Kuhn showed, contradictory facts in and of themselves do not lead researchers to abandon a scientific paradigm; they simply modify the hypotheses that flow

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[78] Clifford Geertz, *The Interpretation Of Cultures* (Basic Books, 1973), 27.

[79] David Gale, "A Theory of N-Person Games with Perfect Information," Proceedings of the National Academy of Sciences of the United States of America 39, no. 6 (1953): 496–501.

[80] Erol Akçay et al., "Evolution of Cooperation and Skew under Imperfect Information," Proceedings of the National Academy of Sciences of the United States of America 109, no. 37 (2012): 14936–41. Globally imperfect information is distinct from locally perfect information. Imperfect information is generally modeled with normal distributions, which allows one to control uncertainty with the parameter of variance (σ). However, entire populations or communities may have significantly different expectations from the mean due to local environmental conditions.

[81] Paul Pierson, *Politics in Time, History, Institutions, and Social Analysis* (Princeton University Press, 2004), 17.

[82] John Antonakis et al., "On Making Causal Claims: A Review and Recommendations," The Leadership Quarterly, Leadership Quarterly Yearly Review, 21, no. 6 (December 1, 2010): 1086–1120. In econometrics, this is known as "simultaneity" or "heterogeneity."

from the theory, until enough such facts have accumulated to justify a new paradigm.[83] In the

social sciences, however, this process can make for near-unfalsifiable theories, since it is

unclear what concrete predictions flow from them.[84] Computational modeling provides a

process to mine both qualitative and quantitative hypotheses from explicitly stated theoretical

premises (see Figure 3).[85]

Figure 3: A stylized view of scientific inquiry showing how models' function in the process

This ability gives the computational approach a number of benefits vis-a-vis

traditional political science methods. Ethically, computation is far superior to social

experimentation, even when it is feasible. Practically, computational methods allow us to

cheaply construct large sample sizes and find approximations to otherwise mathematically

intractable models.[86] Methodologically, computational modeling offers an easy way to build

on the existing knowledge base, since one can simply relax a model's assumptions or change

some parameters in order to discover new theoretical extensions. In this way, computational

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[83] Thomas S. Kuhn, *The Structure of Scientific Revolutions: 50th Anniversary Edition*, (University of Chicago Press, 2012), 55-56.
[84] For an amusing discussion of the many interpretations of Thucydides and the inherent difficulties in evaluating realist claims, see David A. Welch, "Why International Relations Theorists Should Stop Reading Thucydides," Review of International Studies 29, no. 3 (2003): 301–19.
[85] For more on the epistemological aspects of computational modeling vis-a-vis other forms of experimentation, see Eric Winsberg, *Science in the Age of Computer Simulation* (University of Chicago Press, 2010).
[86] A longer discussion of this idea can be found in John H. Miller and Scott E. Page, *Complex Adaptive Systems: An Introduction to Computational Models of Social Life* (Princeton University Press, 2009).

methods could move international relations toward some semblance of a paradigm,[87] rather than a loose collection of hypotheses.

Constructing the Model

The Basics: Agent Properties, Environment, and Shock

Agents have the following four basic properties:

$$C \text{ - Capacity}$$
$$R \text{ - Resources}$$
$$D \text{ - Demand}$$
$$S \text{ - Indicator of Satisfaction}$$

The environment takes from every agent's resources their demand at every time step, and give them resources as a nonlinear function of their capacity and the environmental productivity P:

$$R_{t+1} = R_t - D + e^{PC}$$

Moreover, if $R_{t+1} < 0$ at any time step, the agent's $R = S = 0$, indicating dissatisfaction.

The nonlinearity accurately captures resource accumulation in most societies;[88] whereas a

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[87] For an argument that an international relations paradigm does not currently exist, see Patrick Thaddeus Jackson and Daniel H. Nexon, "Paradigmatic Faults in International-Relations Theory," International Studies Quarterly 53, no. 4 (2009): 907–30.

[88] David Levhari, Leonard J. Mirman, and Itzhak Zilcha, "Capital Accumulation under Uncertainty," International Economic Review 21, no. 3 (1980), 662.

young 16 year-old son may allow a farmer to simply subsist, the same son would allow a warlord to loot and pillage vast resources.

The environmental productivity parameter, on the other hand, gives us the ability to model shock by exogenously changing its value. Again, the nonlinearity makes for the realistic assumption that shocks hurt high-capacity elites more in absolute terms and less in relative terms (it can actually strengthen their position).[89] This particular model instance sets the same demand value D and P for every agent; in our particular application, this rather simplistic assumption makes sense, since cost of living[90] and the productivity losses from large-scale resource shocks tend to be more or less uniform.[91] However, this model can theoretically assign these values from a chosen distribution for cases like societies undergoing rapid urbanization, where the assumption is invalid.[92]

Link Formation

Agents are embedded in a network where they can locally interact with neighboring agents. Specifically, at every time step, they can add a link to one of their neighbors of neighbors, and cut a link from one of their neighbors, unless it's their only neighbor. These links have the following properties:

$$\Delta C \text{ - Capacity transfer}$$
$$\Delta R_{init} \text{ - Resource transfer initially agreed upon}$$

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[89] Rebecca M. Blank, *Changing Inequality*, (University of California Press, 2011), 126-127.

[90] Jonathan Fisher et al., "Inequality and Mobility Using Income, Consumption, and Wealth for the Same Individuals," RSF: The Russell Sage Foundation Journal of the Social Sciences 2, no. 6 (2016): 44–58. At least compared to the distribution of resources, income, or wealth, cost-of-living is largely uniform.

[91] For oil price shocks at least, the impacts tend to ripple through industries and geographic regions. Jared C. Carbone and Kenneth J. McKenzie, "Going Dutch? The Impact of Falling Oil Prices on the Canadian Economy," Canadian Public Policy / Analyse de Politiques 42, no. 2 (2016), 169.

[92] Urban costs of living can be up to 20% higher, even after accounting for wage increases, shows Michael Lipton in "Migration from Rural Areas of Poor Countries: The Impact on Rural Productivity and Income Distribution," *World Development* 8, no. 1 (January 1, 1980), 3.

$$\Delta R_{exp} \text{ - Expected resource transfer}$$

When a link is formed, the agent with the lower capacity transfers capacity over for a per-turn resource amount from the high capacity agent. If a link is cut, the low capacity agent is returned its capacity, and the per-turn resource transfers end. The expected resource transfer value simply keeps track of the average number of resources transferred in some number of previous turns. This allows agents to keep track of those who renege on obligations and calculate the expected utility of a link in a non-naive historically informed fashion.

This construction conforms well with basic intuitions about patron-client relations. The relations are dynamic, especially when agents fail to meet obligations. Unlike traditional ABM, which generally models agents moving on a static spatial lattice grid, this model allows for arbitrary initial network shapes that change over time. Moreover, lower capacity agents, i.e. clients, must trade away capacity in order to gain resources to meet their demand. Concretely speaking, this means that a farmer may give away his son to a warlord's army in order to avoid starvation or gain protection.

Transfer Rates

The calculation for the transfer rate is one of the most important features and contributions of this model. We sample from an exponential distribution to figure out the value of the capacity transfer. An exponential distribution varies with its parameter λ (see Figure 4),[93] so the model sets $\lambda = \frac{1}{U}$, where U represents uncertainty around transaction costs. For higher values of uncertainty U , the probability that one has to transfer high values

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[93] "Exponential Distribution - Wikipedia," accessed May 15, 2018, https://en.wikipedia.org/wiki/Exponential_distribution.

of capacity over a link increases. Once we have sampled a ΔC from our distribution, we simply set ΔR to the geometric mean of the gain that accrues to the high-capacity node H and the loss undertaken by the low-capacity node L during the transfer:

$$Gain_H = e^{P(C_H + \Delta C)} - e^{PC_H}$$

$$Loss_L = e^{PC_L} - e^{P(C_L - \Delta C)}$$

$$\Delta R = \sqrt{Gain_H * Loss_L}$$

Figure 4: Exponential distribution with different values of λ

This setting of the transfer rate resembles realistic patron-client interactions in a number of ways. First, this rule adheres to the basic principle that making this trade is at least expected to be beneficial for both the parties making it.[94] Second, ceteris paribus, clients

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[94] James M. Buchanan and Gordon Tullock, *The Calculus of Consent: Logical Foundations of Constitutional Democracy* (University of Michigan Press, 1965). Of course, it's not necessary to believe that the fact that *some* mutual gain is *expected* for both parties at the time of the transaction makes markets or political patronage some laudable institution of consent. It does however, serve as a useful and generally realistic modeling assumption.

always strictly prefer patrons with higher capacity, since they will be able to transfer them more resources.[95] Third, the distribution of surplus from the transaction is heavily weighted toward the high-capacity agent, which we should expect given patrons' advantageous position in political structures.[96] As a quick example, if a low-capacity agent loses 1 resource and the high-capacity agent gains 64 resources from the trade, then the resource transfer over that link will only be 8 resources. Finally, the uncertainty parameter allows us to model situations where desperate circumstances (like civil war) might make it difficult for a client to predict the extent of the transaction, which could involve risking his life or family to receive patronage.

Utility Function

Because we have stipulated that every possible transfer over a link must necessarily give a net resource benefit to every agent, without a sophisticated utility function, the network would naively add all possible links. Fortunately, our agent specification gives us a natural and intuitive way to weigh the value of resources and capacity at any time step. Formally, the utility measure multiplies a sigmoid function (S-curve) of resources with a hyperbolic sine function of capacity, suggesting that where resources relative to demand determines the trade-off one is willing to make between the two quantities (see Figure 5):

$$Utility \ = \ \frac{2}{1+e^{-(R-D)}} \ * \ \frac{sinh(C)}{sinh(D)}$$

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[95] In civil war situations for example, actors may choose to join insurgencies not for ideological or greed-motivated reasons, but for protection from the strongest actor. R. M. Wood, "Rebel Capability And Strategic Violence Against Civilians", Journal of Peace Research 47, no. 5 (2010), 601.

[96] For a cursory review of the literature on patron-client relations being "characterized by dependency and inequality," see Mahvish Shami, "Collective Action, Clientelism, and Connectivity," The American Political Science Review 106, no. 3 (2012): 588–606.

Figure 5: Utility as a function of resources and capacity, with P=0.5 and D=2.5

As the three-dimensional view shows, agents do not value capacity as much until their resources can fulfill their demand. Moreover, because of the sigmoid, at very low levels of resources (the bottom of the S-curve), agents will not make trades with lower-capacity patrons that only marginally help meet demand. Until demand is met, agents will therefore want to trade capacity for resources. After demand has been met, the exponential function of capacity dominates the utility function, so agents will want to accumulate as much capacity as possible. This makes intuitive sense, since actors can only begin accumulation of capital, political favors, and the means of violence once they can easily provide for their own survival.

This lengthy model specification finally allows us to begin simulating and evaluating different patronage networks, which proxy as regimes. Instead of characterizing regimes by their measures of *participation* and *capacity*, we can characterize them by the *topology* of their patronage network and the *distribution of capacity and resources* on the network. Where a political analyst may use the term democracy, this model would identify a decentralized network; if this proxy seems crude at first glance, we should note that the categorization of vastly different complex political networks as "democracies" is crude to begin with.[97] Distribution of capacity, on the other hand, maps much more directly to political scientific notions of what constitutes a "strong" ruling class or state.[98] By exogenously "shocking" the network and observing how its topology and capacity distribution changes, we can uncover insights about how or why regimes transition under resource shock.

Results: Network Shapes In, Political Hypotheses Out

We begin the simulation with 3 distinct network topologies commonly studied in network science: the Erdos-Renyi random graph model (ER), the Watts-Strogatz small-world graph (WS), and the Barabasi-Albert preferential attachment model.[99] The simulation was run

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[97] The lack of correlation between different measures of democracy suggests that the term is overly laden with subjective value judgments. Thus, characterizing regimes, even if just in the realm of participation, requires a more complex and precise conceptualization. For more on democracy measures, see Edward McMahon and Emilie Kornheiser, "Assessing the Assessors: Correlating Democracy Methodologies," Social Indicators Research 97, no. 2 (2010): 269–77.

[98] Cullen S Hendrix, "Measuring State Capacity: Theoretical and Empirical Implications for the Study of Civil Conflict," Journal of Peace Research 47, no. 3 (2010), 273. Military strength, bureaucratic effectiveness, and patrimonialism all require that the state has an overwhelming resource advantage relative to the population, which fits the model's notion of a high-capacity regime.

[99] For a more thorough treatment of each of these graph generation algorithms, see the following texts. For more on Erdos-Renyi, see Béla Bollobás, *Random Graphs* (Cambridge University Press, 2001). The Watts-Strogatz model is best explained in the original paper: Duncan J. Watts and Steven H. Strogatz, "Collective Dynamics of 'Small-World' Networks," *Nature* 393, no. 6684 (June 1998): 440–42. Similarly,

twice for each model with varying initial connectivity and initial capacity inequality, first

without perturbation into a steady-state, and next with a negative shock value exogenously

delivered halfway through.[100] After briefly introducing the networks, I will present two

multi-faceted hypotheses given the evidence from the model and try to offer a cursory

justification using empirical cases. While these hypotheses require significantly more

empirical testing, they serve as insights that could help in future theorizing and

model-building.

Network Shapes

The ER model's parameter p simply determines how many of the possible links one

adds to the network. If there are 400 possible links in a 20-node graph, we flip an

independent biased coin for each link and add it with probability p. The ER model is

characterized by a relatively low clustering coefficient,[101] a low assortativity,[102] and (for

sufficiently high values of p), a high likelihood that the graph is fully connected.[103] Due to

these properties, it closely parallels a decentralized regime where participation is high and

fragmentation is low (see Figure 6).[104]

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for the Barabasi-Albert model, refer to the source: Albert-László Barabási and Réka Albert, "Emergence of Scaling in Random Networks," *Science* 286, no. 5439 (October 15, 1999): 509–12.

[100] The productivity parameter **P** was reduced from 0.4 to 0.2 halfway throughout the simulation, which was 10 steps total in length. This length of simulation was experimentally determined to be sufficient for a network with 20 nodes to reach a steady-state.

[101] In other words, a node's friends or connections aren't very likely to be connected to each other. N. Meghanathan, "A Random Network Model with High Clustering Coefficient and Variation in Node Degree," in 2015 8th International Conference on Control and Automation (CA), 2015, 54–57.

[102] A network is assortative when high-degree (i.e. well-connected) nodes tend to connect to other high-degree nodes, and low-degree nodes tend to connect to low-degree nodes. Because there is little variation in nodes' degrees in the ER model, the graph tends to be disassortative. Ibid.

[103] For a proof of this fact, see the original paper: P. Erdos and A. Rényi, "On the Evolution of Random Graphs," in *Publication of the Mathematical Institute of the Hungarian Academy of Sciences*, 1960, 17–61.

[104] Figure taken from Neville Curtis et al., "WISDOM-II: A Network Centric Model for Warfare," 2006.

Figure 6: Erdos-Renyi random graphs with varying values of the parameter p

The WS model begins from a ring-like network, where every node is connected to its

k closest neighbors. Then, like in the ER model, we flip an independent biased coin for each

link and add a random connection between any two nodes with probability p.[105] In the

simulation, $k = 2$ for all runs, and we only vary connectivity with p for simplicity. The WS

model is characterized by a high clustering coefficient,[106] medium assortativity,[107] and fairly

high connectivity.[108] Translating these properties back to political networks, we can say that

the WS model corresponds to a decentralized regime where participation and fragmentation

are both somewhat high (see Figure 7).

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[105] This is a slight variant of the original model: M. E. J. Newman and D. J. Watts, "Renormalization Group Analysis of the Small-World Network Model," Physics Letters A 263, no. 4 (December 6, 1999): 341–46.
[106] Marc Barthelemy and Luis A. N. Amaral, "Small-World Networks: Evidence for a Crossover Picture," March 5 1999.
[107] Rogier Noldus and Piet Van Mieghem, "Assortativity in Complex Networks," Journal of Complex Networks 3, no. 4 (December 1, 2015): 507–42.
[108] Note that if a few of the random cross-ring links "fail" or get removed alongside some of the original lattice links, then the graph may break up and cease to be fully connected.

Figure 7: A characteristic small-world network, which becomes a random network as p increases.[109]

Finally, the BA model begins with an empty graph of some nodes, where we start

adding new nodes that attach to m nodes *preferentially*, i.e. they prefer nodes with higher

connections. This simulates a number of real-world networks where well-connectedness is

path-dependent and unequal.[110] In the simulation, we calculate this by setting

$m = p * |V| * 0.5$, where $|V|$ is the number of nodes in the graph and p is the network

parameter that we vary. The BA model is characterized by a somewhat high clustering

coefficient,[111] somewhat low assortativity,[112] and a low likelihood that the graph will stay

fully connected if perturbed.[113] This model may be most realistic for modern-day political

regimes, where a few patrons serve as well-connected hubs, and the network is otherwise

fragmented (see Figure 8).

[109] Watts and Strogatz, "Collective Dynamics," 1998.

[110] Barabási and Albert, "Emergence of Scaling," 1999.

[111] The "hub" nodes serve as connections between small communities of low-degree nodes. N. Eggemann and S. D. Noble, "The Clustering Coefficient of a Scale-Free Random Graph," Discrete Applied Mathematics 159, no. 10 (June 28, 2011): 953–65, https://doi.org/10.1016/j.dam.2011.02.003.

[112] Noldus and Van Mieghem, "Assortativity," (2015).

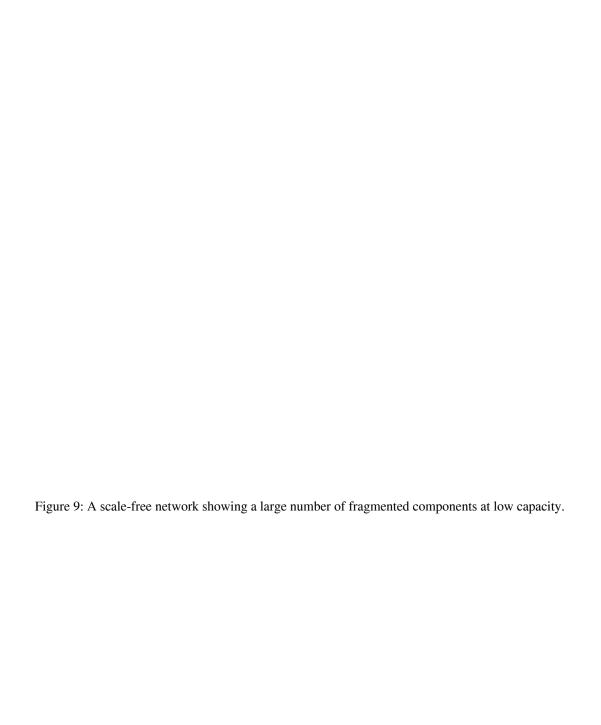[113] Albert-László Barabási and Eric Bonabeau, "Scale-Free Networks," Scientific American 288, no. 5 (May 2003): 60–69.

Figure 8: A scale-free network with highlighted hubs, compared to a random graph.[114]

Hypothesis 1: Regimes with low levels of capacity will be more likely to both fragment and reduce participation when faced with negative shock.

Not only is this result consistent with simulations from each of the three network shapes, but it is also consistent with prior theoretical and empirical work in political science. In the simulation, the centralized scale-free network shows signs of becoming fragmented at low levels of capacity, even in the steady state scenario (see Figure 9). The small-world network similarly fragments, especially when negative shock is introduced (see Figure 10). Perhaps surprisingly, the decentralized ER graph not only fragments, but it also becomes significantly less decentralized. Since there is reduced clustering and increased assortativity (see Figure 11), actors are connected to sparser networks where most of the connections are between nodes with significantly different connectedness and capacity, suggesting the presence of dependency-promoting patron-client relations.

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[114] Figure from Hyunjeong Seo et al., Network-Based Approaches for Anticancer Therapy (Review), vol. 43, 2013.

Figure 9: A scale-free network showing a large number of fragmented components at low capacity.

Figure 10: Small-world network showing signs of fragmentation at low levels of capacity

Figure 11: Random networks display high assortativity and low clustering when exposed to shock.

These findings are intuitive given the existing literature. States with low capacity are prone to greater internal disorder and conflict, since the inability to reach fragmented populations paralyzes the maintenance of control and the provision of public services.[115] In another conceptualization of this dynamic, as Lawrence Markowitz puts it, these cases "succumb to state failure and are defined by fractious state apparatuses, unable to bind the "loyalty" of local elites to a national project of state-building.[116] This seems particularly apt to describe civil war conditions in Somalia[117] and Sierra Leone,[118] where economic shock and the disappearance of "long-distance links" between local elites essentially divides up the society into dozens of unconnected fiefdoms. Moreover, the centralization of an otherwise decentralized, low-capacity regime finds historical backing in the case of Pakistan's military coup in 1958;[119] in cases of economic crisis where the regime fails to appease elites (lowering assortativity), some may use patronage and try to turn popular discontent against the regime. Alternatively, the model's results could be interpreted as the regime moving away from elite clients to more broad-based patronage; although some have criticized this kind of patronage politics for hindering collective action and development,[120] it may in fact help stabilize regimes undergoing shock.[121]

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[115] Timothy Besley and Torsten Persson, "State Capacity, Conflict, and Development," Econometrica 78, no. 1 (2010): 1–34.

[116] Lawrence P. Markowitz, *State Erosion: Unlootable Resources and Unruly Elites in Central Asia* (Cornell University Press, 2013), 124.

[117] As Menkhaus describes, state failure has led to successionism, warlordism, and widespread terrorism. Local elites benefit from this power vacuum and don't believe a strong state would maintain their advantage. Ken Menkhaus, "State Failure, State-Building, and Prospects for a 'Functional Failed State' in Somalia," The Annals of the American Academy of Political and Social Science 656 (2014), 161.

[118] Earl Conteh-Morgan, "Globalization, State Failure, and Collective Violence: The Case of Sierra Leone," International Journal of Peace Studies 11, no. 2 (2006): 87–104.

[119] Ko Maeda, "Two Modes of Democratic Breakdown: A Competing Risks Analysis of Democratic Durability," The Journal of Politics 72, no. 4 (2010), 1131-2.

[120] Javier Auyero, Pablo Lapegna, and Fernanda Page Poma, "Patronage Politics and Contentious Collective Action: A Recursive Relationship," Latin American Politics and Society 51, no. 3 (2009), 7.

[121] Leonardo R. Arriola, "Patronage and Political Stability in Africa," Comparative Political Studies 42, no. 10 (October 1, 2009): 1339–62.

Hypothesis 2: Well-connected and more participatory societies will not only be more robust to economic shock, but also produce better outcomes.

From each of the three simulations, the result regarding connectivity was most consistent. For the small-world network, initial connectivity is by far the most important predictor of whether the graph remains connected and whether agents are satisfied following a negative shock (see Figures 12-13). The scale-free network's results (see Figure 10 above again) adds an important nuance to this analysis; at excessively high levels of connectivity, the graph still breaks up into multiple components because most of the preferentially attached links are to a few select "hub" nodes. Given the choice between higher-capacity patrons and lower-capacity patrons, especially when resources become scarce due to shock, agents will choose the former and cut ties with the latter. Moreover, the simulations for each topology under shock consistently show the best satisfaction ratios at higher levels of connectivity. However, the random graph's output further reveals that *decentralized* well-connected networks will be able to best adapt to provide for agents' cost of living, where it vastly outperforms the other network topologies (see Figure 14).

Figure 12: Small-world networks at high connectivity display significantly less fragmentation under shock.

Figure 13: Small-world networks fulfill agents' demands in the face of shock better with high connectivity

Figure 14	Connectivity Parameter Value	Max. Satisfaction Ratio w/o Shock	Max. Satisfaction Ratio w/ Shock
Small-World	0.9	0.48	0.24
Scale-Free	0.85	0.78	0.44
Random	1.0	0.85	0.55

This result, though seemingly reasonable, actually diverges from conventional analyses of regime transitions under resource shock. Juan Linz, for example, suggests that the presence of a well-connected, robust civil society in an authoritarian regime can make it less

durable.[122] However, according to the experiments presented here, a connected civil society actually allows regimes to rely on patronage networks (potentially independent of the state) to fulfill agents' demands in times of resource shock. In the presence of a sparse network of civil society, like in Nigeria, volatility in resources leads to conflict and maldistribution;[123] in a densely connected network of tribal and business affiliations, like in Saleh's Yemen, the negative political impacts of the volatility of oil revenues can be properly managed.[124] In another influential analysis, Frances Hagopian claims that while democratic transition may not necessarily follow economic growth (à la modernization theory), democratic survival can be explained by development.[125] While this may be true, it understates the ability of participatory regimes to persist through varying economic trajectories. Part of this issue is definitional - Schmitter and Karl, for example stress the importance of "weighted influence" rather than majority rule in democracies, without clarifying what exactly determines these weights.[126] When breaking the black-boxes of what "influence" and "democracy" entail, it becomes clear that notions of participation and connectedness are central to explaining robustness. Haggard and Kauffman note that democracies are more durable when they reduce inequality,[127] but this relationship makes more sense when we flip the causal arrow. As Tim Mitchell convincingly argues, countries where labor is *centrally located in vital energy and economic networks*, organized workers have pushed regimes to democratize.[128] Therefore,

[122] Juan J. Linz and Alfred Stepan, *Problems of Democratic Transition and Consolidation: Southern Europe, South America, and Post-Communist Europe* (JHU Press, 1996), 46.

[123] Nicholas Shaxson, "New Approaches to Volatility: Dealing with the 'Resource Curse' in Sub-Saharan Africa," International Affairs (Royal Institute of International Affairs 1944-) 81, no. 2 (2005), 312.

[124] April Longley Alley, "The Rules of the Game: Unpacking Patronage Politics in Yemen," Middle East Journal 64, no. 3 (2010), 387.

[125] Frances Hagopian, "Political Development, Revisited," Comparative Political Studies 33, no. 6–7 (September 1, 2000), 900. Development, used in this context, just means yearly GDP per capita.

[126] Philippe C. Schmitter and Terry Lynn Karl, "What Democracy Is. . . and Is Not," Journal of Democracy 2, no. 3 (1991): 75–88.

[127] Stephan Haggard and Robert R. Kaufman, *The Political Economy of Democratic Transitions* (Princeton University Press, 1995), 159.

[128] Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (Verso, 2013). Countries with coal tended to democratize because workers were in close contact (i.e. connected) and able to paralyze

conventional characteristics of democracy, like elections, transparency, and media freedoms, may in fact be symptoms of the broader network topology.[129] Where connectedness and network centrality is more equally distributed to begin with, more equal resource distributions help make economic shocks more manageable.

Future Work

There are three main classes of extensions that this model could directly spawn: 1) Changing model parameters; 2) Adding model parameters; 3) Rigorous empirical testing of hypotheses. In the most basic yet natural model extension, there could be a multi-shock pattern for environmental productivity derived from empirical data in order to make the models' insights more testable and tunable. As mentioned in the specification, the model assumes constant demand for each agent, which could be changed to model urbanizing societies. Furthermore, the existing model includes a parameter for transaction cost, and measuring its differential impact across network topologies could prove interesting results about societies' robustness to environmental uncertainties. The current architecture includes no modules for agent communication[130] or conflict,[131] and incorporating existing ABMs for these phenomena into the network could greatly enrich the model's causal linkages. For an ambitious extension, constructing a hierarchical model of these networks could help clarify

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the vital chokepoints of the economy. Neither condition holds for workers in oil states, which explains their authoritarian stability.

[129] This form of the causal relation would also explain "hybrid" democracies where authoritarian characteristics are coupled with only legalistic and nominal participation. Since these measures have been taken without altering the underlying distribution of power on the resource network, they will not lead to the benefits we commonly associate with democracy. Perhaps the best empirical cases of this phenomenon exist in post-1990s Latin America: Alfredo Rehren, *Corruption and Democracy in Latin America* (University of Pittsburgh Press, 2009), 46–59.

[130] Cindy Hui et al., "Simulating the Diffusion of Information: An Agent-Based Modeling Approach," Int. J. Agent Technol. Syst. 2, no. 3 (July 2010): 31–46.

[131] Joshua M. Epstein, "Modeling Civil Violence: An Agent-Based Computational Approach," Proceedings of the National Academy of Sciences 99, no. suppl 3 (May 14, 2002): 7243–50.

the interplay between domestic and international politics. Lastly, the model's rich and dynamic output should be thoroughly validated with statistical time-series models of empirical data and qualitative case studies process-tracing key political junctures.

Conclusion

This paper provides three conceptual and methodological insights with far-reaching implications. First, low-capacity regimes' tendency to fragment means that fledgling new democracies ought to build their extractive and redistributive capacities instead of organizing legalistic and electoral reforms. This prescription does not minimize the importance of legal rights or electoral participation. Rather, it serves as a reminder that negative economic shocks can render these formal measures toothless in the face of shifting patron-client networks. Second, borrowing from the civil society tradition, this study shows that well-connected socioeconomic networks lead to robust political structures and optimal distributional outcomes. While the policy prescription here, namely to promote collective action by native civil society organizations, is not particularly novel, the theoretical implication is highly unconventional; "democracy" is not as useful a conceptual or predictive tool as the notion of a distributive network, which is simultaneously more precise and more general. Finally, computational agent-based modeling on networks is a promising tool for political scientists to create rich yet compact representations of complex phenomena. Methodology co-evolves with conceptual understanding, both of which must become more formal and expressive in future political science scholarship.

Acknowledgments and Other Notes

All code for the model and visualizations can be found on Github. Documentation and other helpful comments will be added shortly:

https://github.com/edwisdom/regime_model