

**INTELLIGENCE WARNING THROUGH ALTERNATE FUTURES OF  
FRAGILE STATES**

by

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I benefited from collaborations from the academic community. Franziska Keller from Columbia University provided insights and many suggestions for improving the arguments in the thesis. Sherry Towers of Arizona State University provided insights on epidemic models and statistics.

## **ABSTRACT**

**TITLE OF THESIS:** Intelligence Warning Through Alternate  
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"All happy families are alike; each unhappy family is unhappy in its own way."

Leo Tolstoy – *Anna Karenina*

The Intelligence Community monitors state fragility because of the severe adverse consequences of state failure. Failed states spawn rapid economic decline, civil strife, trafficking, terrorism, and humanitarian crisis. Historically, failed state pathologies spread across bordering states and the world. One of the primary contributing factors to

state failure, contiguous conflicts, accounts for the concentration of failed states in regions. Sub-Saharan Africa and West Africa are two of those regions.

Several institutions have developed models to forecast political instability, the most recognized being Collier's work for the World Bank. This model employs a sophisticated econometric approach, the careful delineation of correlates from causal factors, and perhaps most importantly the development of accompanying qualitative cases. Significant shortcomings of the models are their problematic forecasting accuracy, inability to encompass external events and third country intercession, and blindness to beneficial democratic transitions. All failed to predict the Arab Spring and would have been incapable of signaling the disintegration of the Soviet Union and reunification of Germany. My thesis advances an approach addressing these shortcomings.

My thesis develops a model of state failure combining established statistical approaches augmented by agent-based modeling to portray uncertainty, encompasses external events, and supports alternate futures and scenarios for a state. The model is applied to Afghanistan explicitly acknowledging uncertainty and alternate futures. This approach sharply contrasts with the current statistical approaches which can only identify correlates from history, ignore extreme behavior, cannot incorporate external events, and do not support scenario development.

## **CHAPTER 1**

### **Research Proposal**

Strategic Indicators and Warning (I&W) are key issues in intelligence, especially regarding fragile states. There are various ways to address this issue, and this thesis focuses on a method that should prove useful to intelligence analysts. Therefore, this thesis 1) develops an agent-based model of state fragility using statistical analysis based on a small number of economic, military, political, and social factors, 2) adapts the general model to Afghanistan, and 3) generates alternative futures. Alternate futures are generated by two mechanisms: from the use of probability distributions for factors, and scenarios generated from adjusting internal and external factors.

An agent-based model is a computer model executed on a space either representing the geographic and demographic attributes of a territory or a network of relationships. The agents represent people or groups with similar attributes. These agents are distributed across the space and endowed with attributes which includes preferences, how they receive information, and how they interact. One central concept is that agents modify their actions and preferences through mainly local information and interactions. Finally, agent placement and attributes are typically determined using probability distributions which create multiple versions of the future.

Consequently, my thesis addresses the hypothesis that statistical analysis can be used to construct an agent-based model to provide indicators and warnings of onsets of violence for fragile states. This model can be adapted to individual states by adjusting the explanatory factors to match their current values. Alternate futures of a state can be

constructed through scenarios and by drawing these factors from probability distributions. This agent-based model will be tested on Afghanistan.

The Intelligence Community has been keenly aware of this issue, and since 1994, the CIA has funded the Political Instability Task Force (PITF) to provide unclassified models forecasting political instability and failed states.<sup>1</sup> The Political Instability Task Force sponsors ten to fifteen scholars and the compilation and maintenance of an open-source database of onsets of conflict and contributing factors. The database captures the timing of adverse events which signal state failure and the duration of failure. In the PITF, state failure is segregated into four types; revolutionary war, ethnic war, adverse regime change, and genocide or politicide. Entrance criteria to meet these classifications are 1,000 deaths per year related to political instability. The database spans from 1955 to the present and includes the correlative factors of political instability, such as regime type, infant mortality, armed conflict in contiguous states, and various economic and demographic statistics.

For example, the invidious effects of corruption from elites in fragile states create a spiral towards failure. Additionally, organized criminal violence, often endemic in weak states, undermines the internal fabric of society. The following two figures and the commentary on drug trafficking and spillover of conflicts come from the World Development Report 2011 published by The World Bank illustrate this problem.<sup>2</sup>

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1. Political Instability Task Force, <http://globalpolicy.gmu.edu/political-instability-task-force-home/> (accessed October 12, 2013).

2. The World Bank, *World Development Report 2011: Conflict, Security, and Development* (Washington D.C.: The World Bank, 2011), <http://web.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/0,,contentMDK:23256432~pagePK:478093~piPK:477627~theSitePK:477624,00.html> (accessed February 26, 2014), (accessed February 26, 2014).

Figure 1 demonstrates that states with weak territorial control and exploitable resources are targets for criminal activity which then spills into neighboring states. Rebel activity appears indifferent to state sovereignty, and this figure focuses on cocaine transshipment financed by local resources such as diamonds, timber, and oil. Furthermore, the value of cocaine is so large that bribes can equal a lifetime salary for officials involved in aiding traffickers. These bribes corrode any attempts at governance and are the catalyst for security breaches spiraling the society towards failure.

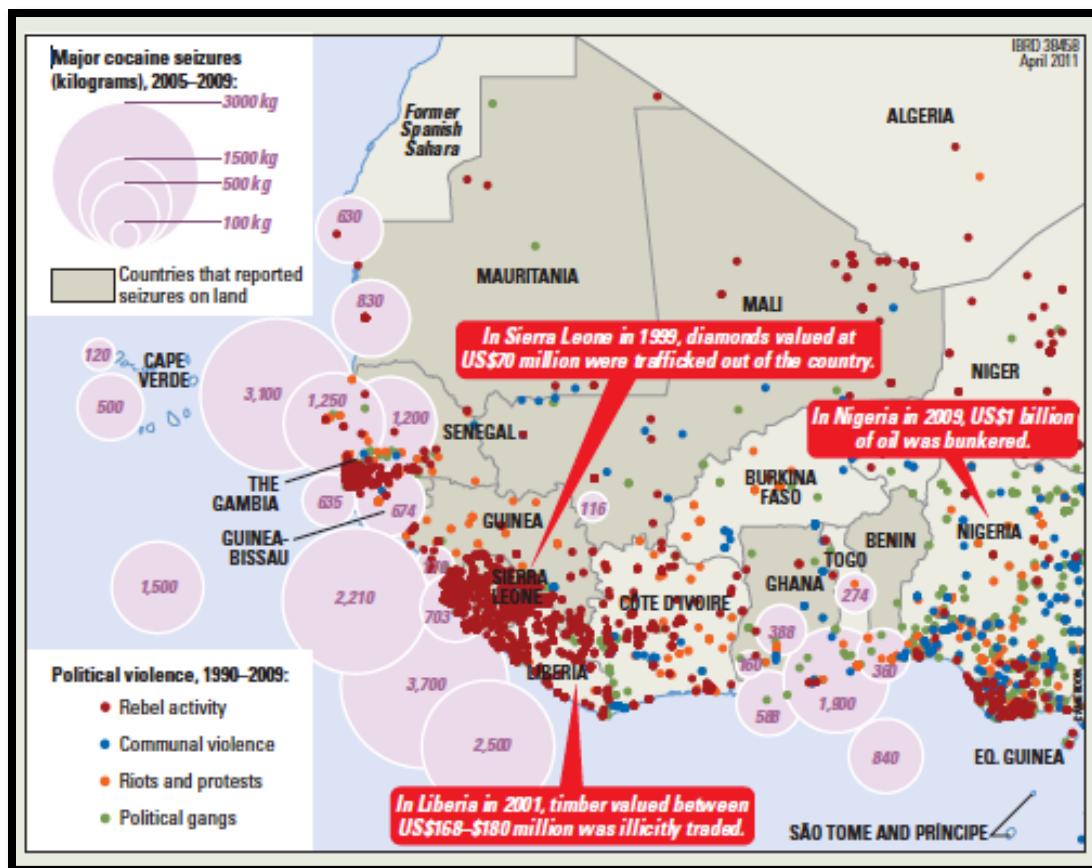


Figure 1. Trafficking and violence during conflicts in West Africa, 1990-2009<sup>3</sup>

3. The World Bank, *World Development Report 2011*, 56.

Figure 2 demonstrates the irrelevance of weak state borders and the diffusion of rebel groups outside their state. These rebel groups are not motivated by grievance, the World Development Report states, “Much of their *raison d'être* has become profit, plunder, or simple subsistence, with political goals at times stronger, at times weaker.”<sup>4</sup>

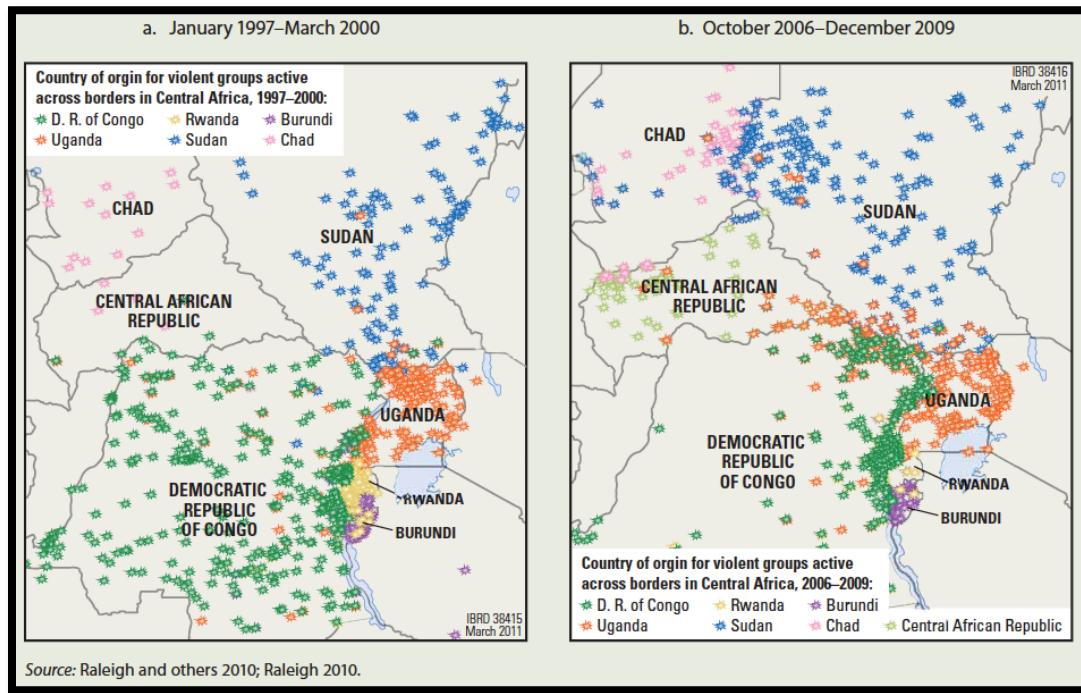


Figure 2. Cross-border political violence across Central Africa<sup>5</sup>

4. The World Bank, *World Development Report 2011*, 77.

5. Ibid., 77.

I extract events in the 10 failed states leading the Fund For Peace Failed States Index in order to identify intelligence concerns.<sup>6</sup> Timely intelligence is required to anticipate and help policymakers moderate the spillover of many of these events across neighboring states:

- Somalia – suicide attacks, piracy, famine
- Democratic Republic of the Congo – indiscriminate rebel attacks, torture, rape (it is the rape capital of the world), killing, disease (Ebola and Cholera), refugees
- Sudan – armed conflict, food and medical crisis, violent clashes during demonstrations
- South Sudan – armed conflict, endemic corruption, refugees, murder of journalists
- Chad – desertification and drought, armed gangs and violence, refugees
- Yemen – massive protests, human rights violations, refugees, starvation, disease, drone attacks
- Afghanistan – 'green on blue' violence, violent protests, assassinations of local leaders
- Haiti – widespread corruption, large protests, abysmal medical system
- Central African Republic – natural disasters (flooding) impacting food supply and spreading disease, violence and abductions from conflict, riots and protests, French military presence, coup overthrowing government, religious hatreds
- Zimbabwe – widespread human rights violations, protests

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6. The Fund for Peace, *Failed States Index: IX 2013* (Washington D.C.: The Fund for Peace, 2013), 15-20, <http://failedstatesindex.org>, (accessed October 8, 2013).

The high concentration of fragile and failing states within regions has emphasized the primary contributing factor to failure, i.e., conflicts in contiguous states. The world map (Figure 3) from *Peace and Conflict 2012* demonstrates the concentration of fragile and failed states in sub-Saharan Africa (20 of the 46 African states, 43% are in the high risk category).<sup>7</sup>

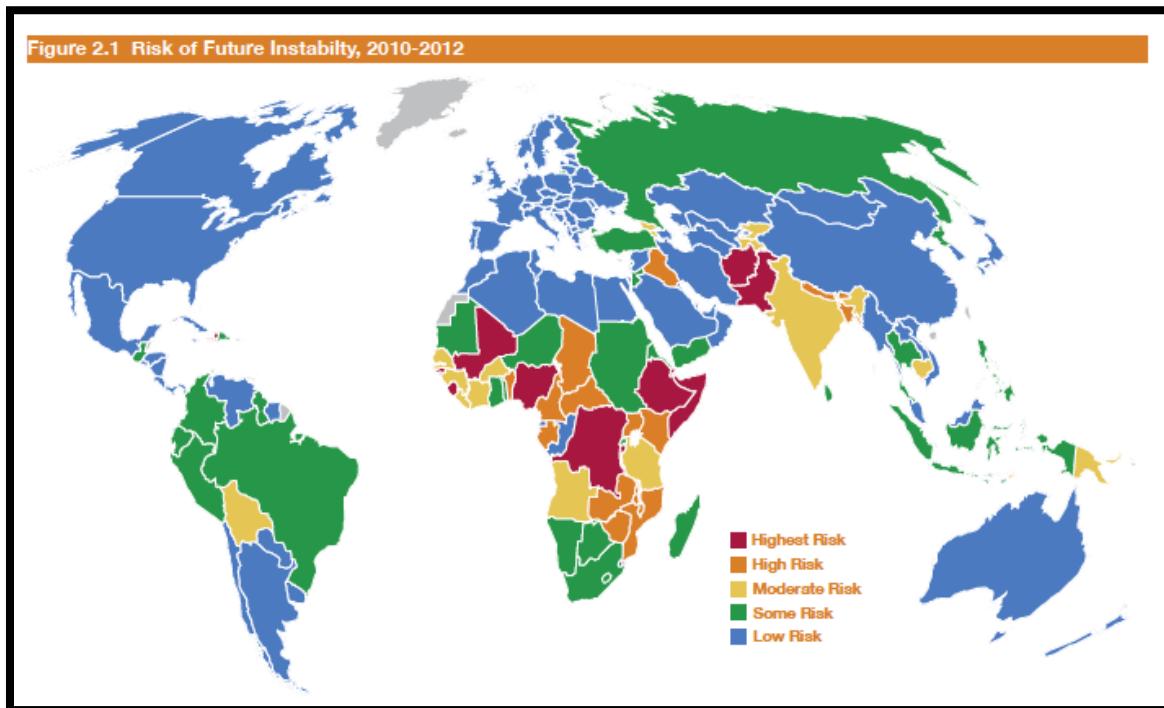


Figure 3. Risk of Future Instability, 2010-2012<sup>8</sup>

7. Center for International Development and Conflict Management, *Peace and Conflict 2012* (College Park, MD: CIDCM, 2012), 5,  
[http://www.cidcm.umd.edu/pc/executive\\_summary/exec\\_sum\\_2012.pdf](http://www.cidcm.umd.edu/pc/executive_summary/exec_sum_2012.pdf) (accessed February 26, 2014).

8. Ibid., 5.

Conflict is such a contributing factor to state fragility that the British Department for International Development (DFID) addresses the problem as fragile and conflict-affected states and situations (FCAS). Intelligence is a necessary ingredient to frame intervention or policies because according to DFID;

All interventions into FCAS are potentially harmful. Our interventions may bolster a failing government, strengthen the hand of a minister or faction within a government, bring down a government, increase or decrease conflict between different communities or undermine state-society relations.<sup>9</sup>

This is a long-term strategic problem, and the World Bank states that evidence shows that it takes 15-30 years for a state to recover from the institutional capacity of a fragile state such as Haiti.

The severity of the problem is compounded by the difficulty, years, and international effort required for a failed state to recover. This is evident from the fact even a small number of new episodes can help create unstable political environments in 28% of world states. Figure 4 maps the new episodes of violence (under 4 per year) and its effect on states.

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9. United Kingdom, Department for International Development, *INTERIM GUIDANCE NOTE: Measuring and managing for results in fragile and conflict-affected states and situations* (London: Department for International Development, 2012), 7, <https://www.gov.uk/government/publications/results-in-fragile-and-conflict-affected-states-and-situations> (accessed February 26, 2014).

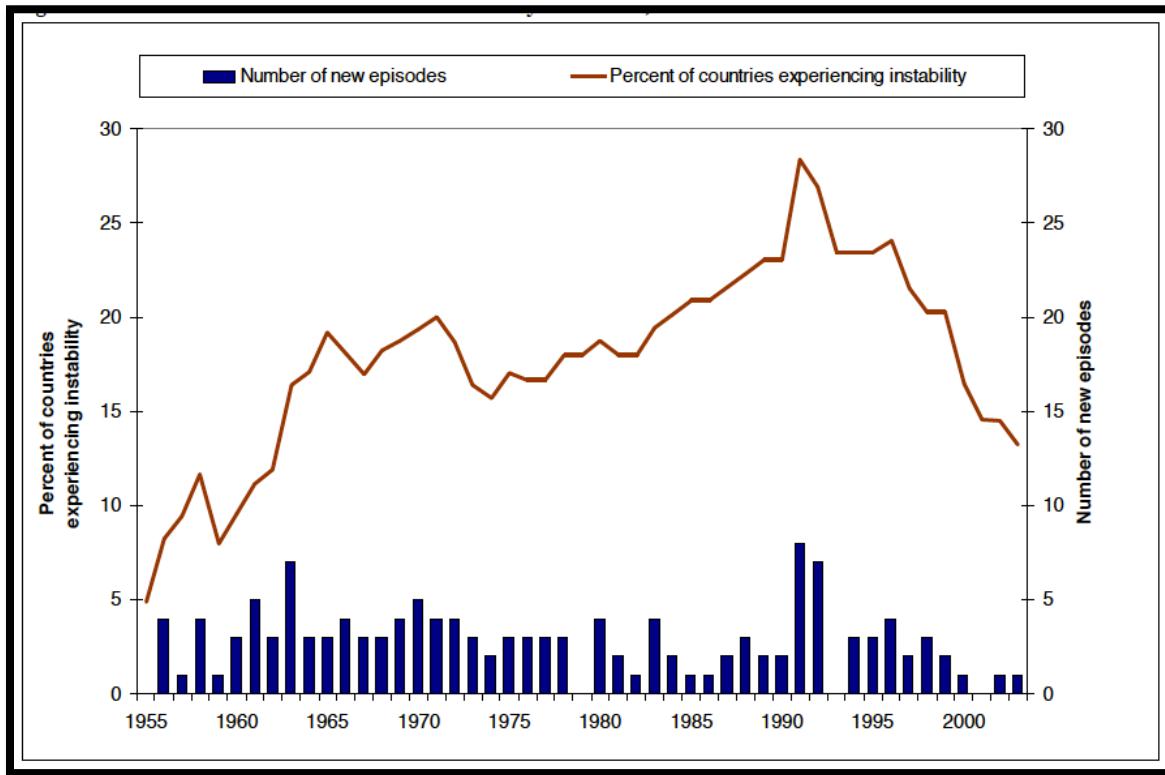


Figure 4. Worldwide Instability, 1955-2003<sup>10</sup>

Robert Rotberg describes the failed state process as:

Nation-states fail when they are consumed by internal violence and cease delivering positive political goods to their inhabitants. Their governments lose credibility, and the continuing nature of the particular nation-state itself becomes questionable and illegitimate in the hearts and minds of its citizens.<sup>11</sup>

10. Jack Goldstone et al., “A Global Forecasting Model of Political Instability”, (paper for Annual Meeting of American Political Science Association, September 1-4 2005), appendix, <http://globalpolicy.gmu.edu/documents/PITF/PITFglobal.pdf> (accessed February 26, 2014).

11. Robert Rotberg, ed., Introduction, *When States Fail: Causes and Consequences* (Princeton: Princeton University Press, 2004), 1.

Because a failed state is what our Indicators and Warnings are designed to predict, this work focuses on the economic, political, security, and social factors associated with fragile states, which constitutes the stage before failed states. There exists a consensus within the policy and donor communities around the Organization for Economic Co-operation and Development (OECD) definition of fragile states which is formulated in *Principles for Good International Engagement in Fragile States and Situations*:

States are fragile when state structures lack political will and/or capacity to provide the basic functions needed for poverty reduction, development and to safeguard the security and human rights of their populations.<sup>12</sup>

Following Erin K. Jenne, my thesis also separates fragile states into two categories, weak states and fragmented states.<sup>13</sup> Weak states are unable or unwilling to provide basic services to their citizens, while fragmented states are unable to exercise control over all of their territory. Therefore, Jenne and others object to the characterization of North Korea as a “strong” state because of its seemingly unlimited repressive power and its tolerance of starvation among the population. This two-dimensional view highlights the intelligence problems of fragile states. Weak states (North Korea for example) tend to be closed societies and are largely impenetrable to human intelligence, they also lack reliable economic and social statistics, and elite motivation is opaque. History proves that western powers and non-governmental organizations (NGOs) have been easily deceived by the alleged “moderating” conduct of elites in weak states into changing our intelligence analysis and policy options.

Fragmented states (Colombia, for example) are defined by large ungoverned regions

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12. OECD (Organisation for Economic Co-operation and Development). 2007. *Principles for Good International Engagement in Fragile States & Situations* (Paris: OECD, 2007), 2, <http://www.oecd.org/dacfragilestates/43463433.pdf> (accessed February 26, 2014).

13. Erin K. Jenne, “Sri Lanka: A Fragmented State”, in Robert I. Rotberg ed., *State Failure and State Weakness In a Time of Terror, Failed States Book*, (Washington D.C.: Brookings Institution Press, 2003), 222.

enabling criminal, rebel, and terrorist groups to foment civil conflict over prolonged periods while both government and rebels prey on the population. Near-failed states (Pakistan for example) fail on both dimensions; they do not provide adequate social services nor do they control their territory. Figure 5 demonstrates the dynamic nature of this classification by tracing the promotion of Liberia from Jenne's 2003 classification to their 2012 status.

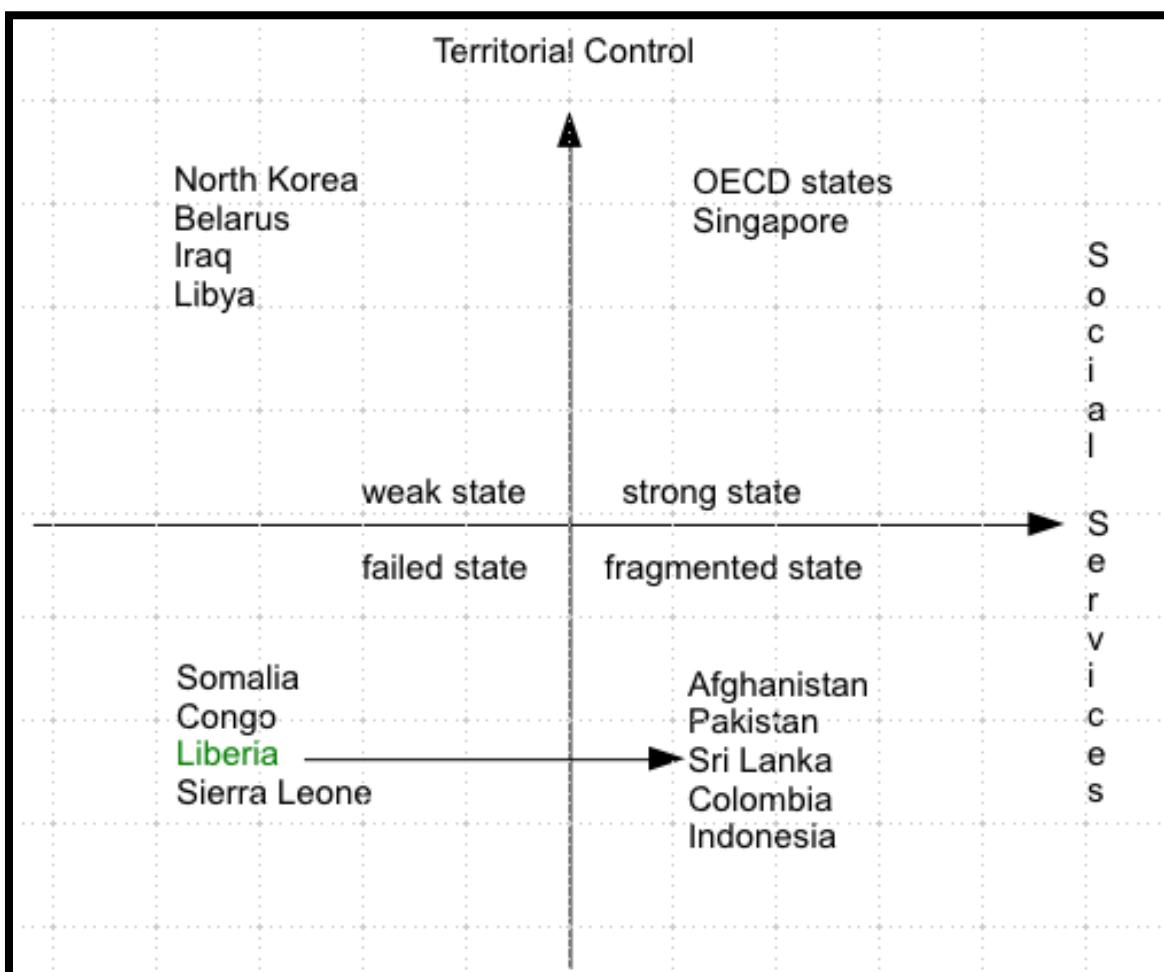


Figure 5. Weak and Fragmented States<sup>14</sup>

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14. Ibid., 222.

Again, with the Arab Spring, the intelligence and policy communities were stunned by the outbreak and contagion of protests in much the same way as they were with the disintegration of the Soviet Union in the 1990s. Unfortunately, the major approaches to Indicators and Warnings outlined in the next section are still not capable of detecting mass protests possible leading to democracy. At best these measures may capture adverse regime change, not democratic regime change accomplished through peaceful means. That is why this thesis advocates a different approach.

## CHAPTER 2

### Theory and Literature Review

That is the issue that will continue in this country when these poor tongues of Judge Douglas and myself shall be silent. It is the eternal struggle between these two principles—right and wrong—throughout the world. They are the two principles that have stood face to face from the beginning of time, and will ever continue to struggle. The one is the common right of humanity, and the other the divine right of kings. It is the same principle in whatever shape it develops itself. It is the same spirit that says, "You toil and work and earn bread, and I'll eat it." No matter in what shape it comes, whether from the mouth of a king, who seeks to bestride the people of his own nation and live by the fruit of their labour, or from one race of men as an apology for enslaving another race,—it is the same tyrannical principle....

Lincoln's reply to Douglas in the Seventh and Last Debate<sup>15</sup>

Abraham Lincoln draws us into the post-cold war challenge; violence within a state. My thesis draws on Lars-Erik Cederman's works on the formation and disintegration of states and his focus on nationalities and geography in civil conflict. It also draws on Victoria Hui's analysis of state formation in China and early modern Europe, and other key works.<sup>16</sup> These works include: Rotberg's multi-year study on failed states conducted at Harvard, the CIA funded database, and studies, Joshua Epstein's agent-based formulation of civil conflict, and the Daron Acemoglu's and James Robinson's theory of the economic and political factors of why states fail.<sup>17</sup> This literature ranges from individual case studies to sweeping historical studies. The studies

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15. Abraham Lincoln, *Speeches and Letters of Abraham Lincoln, 1832-1865* (Kindle), 132.

16. Lars-Erik Cederman, *Emergent Actors in World Politics: How States & Nations Develop and Dissolve* (Princeton: Princeton University Press, 1997), and Victoria Tin-bor Hui, *War and State Formation in Ancient China and Early Modern Europe* (New York: Cambridge University Press, 2005), 168.

17. Robert I. Rotberg, ed., *State Failure and State Weakness In a Time of Terror, Failed States Book* (Washington D.C.: Brookings Institution Press, 2003); Robert I. Rotberg, ed., *When States Fail: Causes and Consequences* (Princeton: Princeton University Press, 2004); Joshua Epstein, "Modeling civil violence: An agent-based computational approach," Proceedings of the National Academy of Sciences, May 14, 2002; Daron Acemoglu and James A. Robinson, *Why Nations Fail* (New York: Crown Publishers, 2012); and Victoria Tin-bor Hui, *War and State Formation in Ancient China and Early Modern Europe* (New York: Cambridge University Press, 2005).

employ quantitative methodologies ranging from statistical analysis across a broad range of years and states, powerful economic/econometric formalism, and agent-based modeling. Additionally, my work has benefited from collaborating with Franziska Keller, a scholar currently doing field research in countries of the former Soviet Union.<sup>18</sup>

*Why Nations Fail* develops the political, economic, and historical factors that shape the rise and fall of nations.<sup>19</sup> Acemoglu and Robinson frame this analysis against the divergence of per capita income beginning in the 16th century and accelerating during the Industrial Revolution. Today, this results in a per capita differential of up to ten to one (10:1) between developed and non-developed countries (Figure 6). Figure 6 displays log GDP (natural logarithm of Gross Domestic Product) per capita in dollars. The divergence is apparent when the natural logarithm of GDP on the y axis is translated to GDP using the relationship  $GDP = \text{exponential}(y)$ . Thus 10 equates to a GDP of \$22,026, 9 to \$8,103, 8 to \$2,981, 7 to \$1,097, and 6 to \$403. Statistical analysis identifies states falling in the bottom quartile of income as one of the primary correlative factors of state fragility and failure. Certainly low income cripples the ability of the state to provide social services, condemning citizens to disease, poverty, inadequate health care, and reduced opportunities.

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18. Franziska Keller, “(Why) Do Revolutions Spread?” (APSA 2012 Annual Meeting Paper), <http://ssrn.com/abstract=2108790> (accessed 31 August 2013).

19. Acemoglu and Robinson, *Why Nations Fail*.

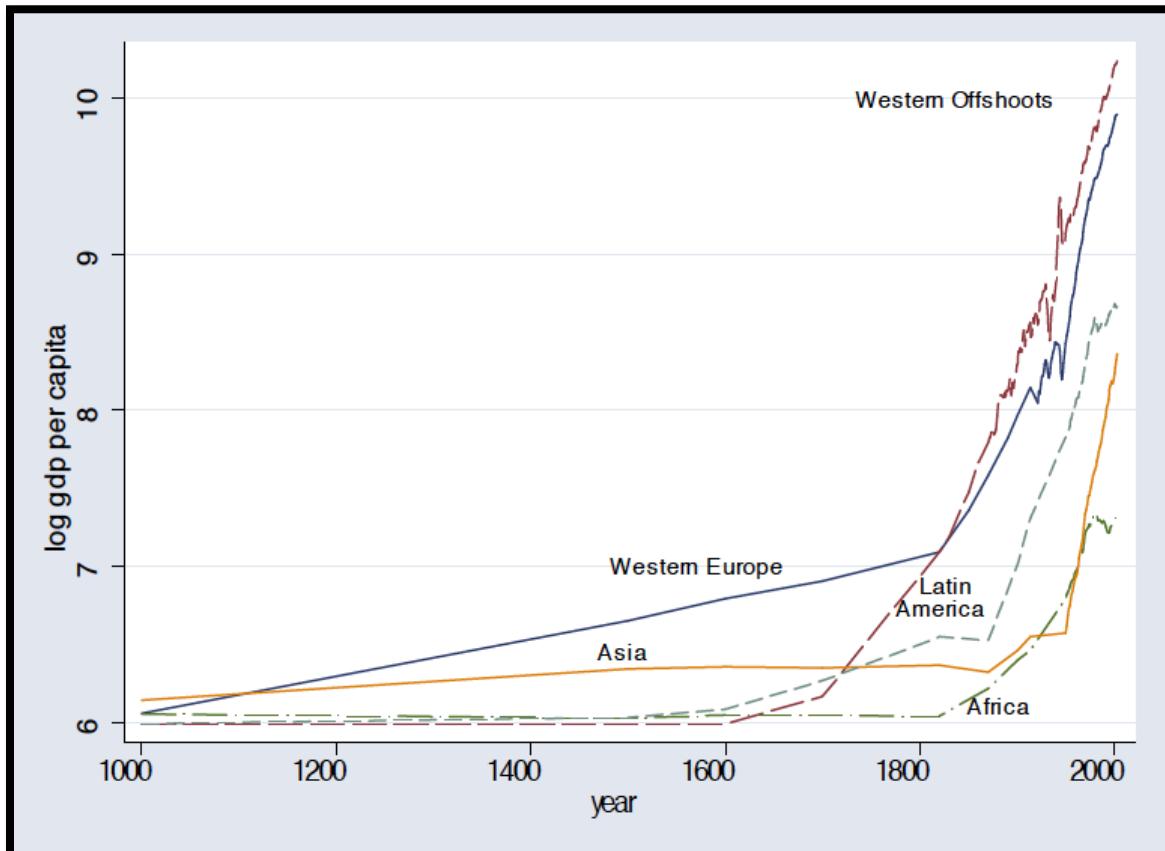


Figure 6. Divergence of Income<sup>20</sup>

Acemoglu and Robinson attribute the principal causes for this divergence to be the gradual adoption of inclusive economic and political institutions in the West, while most nations retained extractive institutions. Inclusive economic institutions are built on secure property rights, effective state services supporting education, health, and justice, and opportunities for citizens. These measures create a positive environment encouraging invention, innovation and economic growth (capital formation/human capital). Inclusive political institutions require broad citizen participation, rule of law, and checks on the elite. At the extreme, extractive political and economic institutions are

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20. Daron Acemoglu, “Why Nations Fail” (lecture at MIT April 27, 2011), <http://economics.mit.edu/files/6699> (accessed February 22, 2014).

absolute autocracies. The authors consider the popular alternate explanations for economic divergence by Montesquieu, Max Weber, and Jared Diamond. Their explanations related to culture, religion, geography, resources, and geographic latitude, are systematically explored and found wanting. Acemoglu and Robinson refute these through striking historical narratives. The path of the two Koreas is the most relevant for our purposes.

Korea is an excellent controlled test of the authors' theory. Korea was partitioned in 1945 with north and south emerging with identical history and culture at economic parity. The narrative traces South Korea's evolution from a dictatorship with inclusive economic institutions to a democracy while North Korea maintained extractive institutions. South Korea moved to what the authors label a "virtuous circle" -- inclusive economic institutions creating the basis for inclusive political institutions. However; North Korea's extractive economic and political institutions spiraled its economy into a "vicious circle" resulting in a 10 times per-capita income gap by 1998 (see Figure 7).

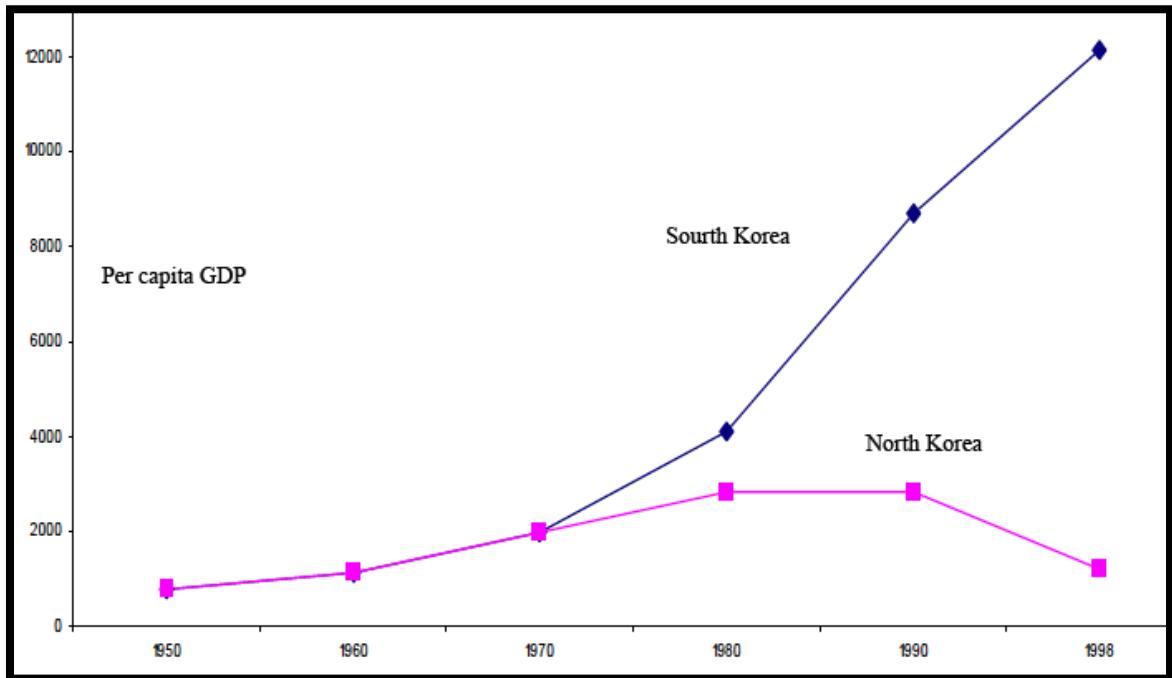


Figure 7. Divergence of North and South Incomes (GDP per capita)<sup>21</sup>

The chart below (Figure 8) maps the dynamics of these factors. The arrows indicate that countries have a propensity to move towards both inclusive or both exclusive institutions (the arrows point away from a mixture of inclusive and exclusive attributes). This creates virtuous or vicious circles. In a virtuous circle, inclusive political institutions lead to greater education and employment opportunities and restraints on monopolies and cronyism unleashing competition, innovation and growth through inclusive economic institutions. In a vicious circle, extractive political institutions exploit the majority of the population, and block innovation and change because it challenges the interests of the elite. These extractive institutions lead to

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21. Daron Acemoglu, “Understanding Institutions”, (Lionel Robbins Lectures, London School Economics, 2011), <http://economics.mit.edu/files/1353> (accessed February 22, 2014).

economic stagnation and a negative spiral from the competitive pressures exerted by growing economies.

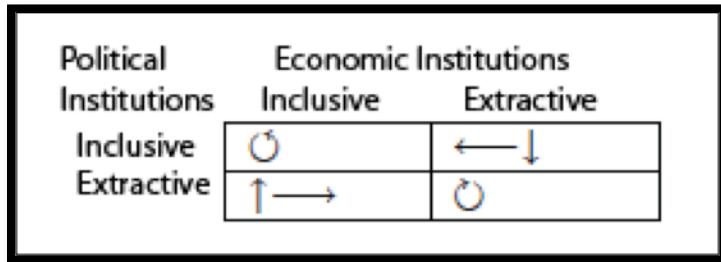


Figure 8. Virtuous and Vicious Circles to Equilibrium<sup>22</sup>

This covers the how and why, but as analysts we must judge the when. Here, Acemoglu and Robinson agree with Yogi Berra's quote, "It is difficult to predict, especially about the future."

The authors demonstrate the structure of their argument when discussing the timing of events. They attribute the divergent paths of history to small institutional differences influencing actions at critical junctures. Neither the actions nor their efficacy are predictable. Moreover; the critical junctions are ephemeral, meaning action delayed is opportunity lost. The authors' memorable term for this evolution is "the contingent path of history." They caution against reading history backwards to uncover an inevitable path forward.

In several sections the authors exercise the contingent nature of history constructing alternative histories. What if the Spanish Armada was successful? What if the Stuarts defeated William of Orange in 1688 and preserved absolutism in England? What if China engaged in international trade and became a major naval power several

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22. Acemoglu, "Why Nations Fail lecture"

hundred years before Europeans? What if the Ming had not destroyed their own navy in the late fourteenth century? Intelligence professionals have also advocated the use of alternate hypothesis to improve intelligence products.

The following justifications for modeling of alternate futures were developed in a paper published by the author of this thesis in *Intelligence and National Security*.<sup>23</sup>

Thomas Fingar, dedicated a chapter of his recent book to the neglected role of intelligence to anticipate opportunities and shape the future.<sup>24</sup> An Intelligence Community better able to estimate the potential influence of both policymaker and adversary decisions will be better poised to avoid surprises and reduce the chances of future intelligence failures.

By enlarging the set of questions and hypothetical situations that may be posed, agent-based modeling permits us to productively explore and investigate the potential influences of path-dependent decisions by key agents. Such models would help to focus funding and efforts where the largest intelligence benefits might be realized by identifying regions where the policy maker may anticipate opportunities and shape the future. These models might be used to help explore a system's robustness to both random and strategic attack.<sup>25</sup>

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23. Daniel Javorsek II, and John G. Schwitz, "Probing Uncertainty, Complexity, and Human Agency in Intelligence," *Intelligence and National Security*, December 2013, <http://www.tandfonline.com/doi/abs/10.1080/02684527.2013.834218?tab=permissions#tabModule>, (accessed February 22, 2014).

24. Thomas Fingar, *Reducing Uncertainty* (Stanford: Stanford University Press, 2011).

25. Sergey V. Buldyrev, Roni Parshani, Gerald Paul, H. Eugene Stanley, and Shlomo Havlin, "Catastrophic Cascade of Failures in Interdependent Networks," *Nature* 464 (2010):1025-1028.

Epstein, a leader in the field, states what he believes is a defining principle justifying agent-based modeling, “If you didn’t grow it you didn’t explain its emergence.”<sup>26</sup>

Epstein defines the strengths of agent-based modeling in social science.

The agent-based computational model – or artificial society – is a new scientific instrument. It can powerfully advance a distinctive approach to social science, one for which the term “generative” seems appropriate. To the generativist explaining the emergence of macroscopic societal regularities, such as norms or price equilibria, requires that one answer the following question.

How could the decentralized local interactions of heterogeneous autonomous agents generate the given regularity?<sup>27</sup>

I find fault with the Realist International Relations conception of states traceable to Hobbes because of the following: its exposition of anarchy as the root of state interactions, its inability to explain state formation or dissolution, and its abandonment of justice and morality as explanatory factors. This thesis, guided by Gallarotti's article on Hobbes enduring influence on Realistic International Relations, outlines the disputed positions.<sup>28</sup> Hobbes's conception of the state as Leviathan imbued with human attributes counters the basic principles of agent-based modeling. Agent-based models are constructed from local and bounded interactions of many agents, there is no commanding Leviathan, and the state cannot be reified as a unitary actor. I quote Hobbes's to root his theory in 1651 England. Hobbes derives a structuralist theory from this state of anarchy which overrides human agency and justifies actions unrestrained by morals or concepts of

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26. Joshua M. Epstein, *Generative Social Science: Studies in Agent-Based Computational Modeling*, (Princeton: Princeton University Press, 2006), 8.

27. Ibid., 5.

28. Giulio Gallarotti, “The Enduring Importance of Hobbes in the Study of IR”, e-International Relations, January 10, 2013, <http://www.e-ir.info/2013/01/10/hobbes-is-still-extremely-relevant-for-the-study-of-ir-especially-the-cosmopolitan-hobbes/> (accessed 31 August 2013).

justice. Actions result from the structure of inter-state actors independent of human agency:

There is Alwayes Warre Of Every One Against Every One Hereby it is manifest that during the time men live without a common Power to keep them all in awe [Leviathan], they are in that condition which is called Warre". . . [which justifies] To this warre of every man against every man, this also is consequent; that nothing can be Unjust. The notions of Right and Wrong, Justice and Injustice have there no place. Where there is no common Power, there is no Law: where no Law, no Injustice. Force, and Fraud, are in warre the two Cardinall vertues.<sup>29</sup>

This Realist International Relations concept of states derived from Hobbes and the identification of states as a strictly western phenomena are insufficient for this study on state dissolution. For this, we must differentiate nation from state, examine the dynamic process of state formation and search for counterfactuals. In general, economists and social scientists cannot conduct experiments with controls permitting the determination of causal factors. Therefore; they depend on counterfactual analysis, similar historical situations resulting in contrary outcomes. This provides a rich source for model generation by clarifying the effects and contingency of factors.

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29. Thomas Hobbes, *Leviathan* (St. Paul's Churchyard: Andrew Crooke, 1651), 56-57.

Modifying structuralist theory requires differentiating between the nation and the state. Weber defines the state as an entity exercising legitimate control over its territory, undisturbed by internal disputed power or external intervention.<sup>30</sup> Weber does not define nation simply as the polity or a checklist of polity attributes. Weber describes the nation in the following manner:

If the concept of 'nation' can in any way be defined unambiguously, it certainly cannot be stated in terms of empirical qualities common to those who count as members of the nation. In the sense of those using the term at a given time, the concept undoubtedly means, above all, that one may exact from certain groups of men a specific sentiment of solidarity in the face of other groups. Thus, the concept belongs in the sphere of values. Yet, there is no agreement on how these groups should be delimited or about what concerted action should result from such solidarity.<sup>31</sup>

The nation can be viewed as a necessary precursor to the formation of a state. Molding a national consciousness is a complex process of long duration formed through shared experiences and tribulations. There are notable exceptions to taking the simplistic approach of defining nations on homogenous attributes such as religion, language, and common heritage. Multilingual Switzerland has been stable for over 500 years. Certainly the US contains a multiplicity of ethnicity, race, and religion. Also noted is that one of the leading failed states, Somalia, is homogenous with respect to ethnicity and religion.

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30. Max Weber, *Essays in Sociology*, trans. and ed. by H. H. Gerth and C. Wright Mills (New York, Oxford University Press, 1946), 78.

31. Max Weber, 'The Nation', in *From Max Weber: Essays in Sociology*, trans. and ed. by H.H. Gerth and C. Wright-Mills (Routledge & Kegan Paul: London, 1948).

Rotberg discusses the dynamic character of state formation and dissolution.<sup>32</sup> In 1914 after the disintegration of the Ottoman and Austro-Hungarian empires there were 55 states which grew to only 69 by 1950. Independence in Africa brought the total number of states to 90. The addition of many more African, Asian, and Oceanic states, and the implosion of the Soviet Union brought the total to 191. The fact that these “recent” states were not shaped by a national sense of identity contributes to their fragility.

Cederman describes how events shifted the Realist International Relations (IR) focus of the cold war on interstate rivalries, toward the more fundamental problem of state formation and disintegration.

The fall of the Berlin Wall in 1989 triggered an astonishing series of epochal events that led to the dissolution of multiethnic communist states and the creation of dozens of new sovereign units. While the collapse of communism accelerated the splintering of the Soviet Union, Yugoslavia, and Czechoslovakia, other parts of Europe experienced a trend toward unprecedented levels of political integration. Germany reunited and despite certain delays associated with the ratification of Maastricht Treaty, Western European integration progressed toward a deeper and wider union.<sup>33</sup>

Cederman develops a number of agent-based models demonstrating the effects of ethnicity and ungoverned territory on fragmenting states. If conflict is one of the prime contributors to state failure, Acemoglu and Robinson confound this because:

The evidence is, therefore, consistent with the notion that most moves toward democracy happen in the face of significant social conflict and possible threat of revolution. Democracy is usually not given by the elite because its values have changed. It is demanded by the disenfranchised as a way to obtain political power and thus secure a larger share of economic benefits of the system.<sup>34</sup>

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32. Robert I. Rotberg, *When States Fail*, 2.

33. Lars-Erik Cederman, *Emergent Actors In World Politics*, 3.

34. Daron Acemoglu and James A. Robinson, *Economic Origins of Dictatorship and Democracy* (New York: Cambridge University Press, 2006), 29.

In the search for counterfactuals (similar historical situations resulting in contrary outcomes) Victoria Tin-bor Hui explores east west parallels and different outcomes of state formation:

The Eurocentric conventional wisdom holds that the West is unique in having a multistate system in international relations and liberal democracy in state-society relations. . . . In fact, China in the Spring and Autumn and Warring States periods (656-221 BC) was a system of sovereign territorial states similar to Europe in the early modern period. In both cases this formative period witnessed the prevalence of war, formation of alliances, development of centralized bureaucracy, emergence of citizenship rights, and expansion of international trade. This book examines why China and Europe shared similar processes but experienced opposite outcomes.<sup>35</sup>

Any attempt to adapt a general agent-based model to the history and economic and geographic setting of a state requires a study of that state. Unfortunately, the strategic location of Afghanistan, the state modeled in this thesis, has subjected it to repeated conflict from outside forces. In modern times this was named “The Great Game” to describe the strategic rivalry of the British and Russian Empires. The result has been three Anglo-Afghan Wars and invasions by the Soviet Union and the West. The results of the Second Anglo-Afghan war were summarized by Lord Hartington, the Liberal secretary of state for India:

As the result of two successful campaigns, of the employment of an enormous force, and of the expenditure of large sums of money, all that has yet been accomplished has been the disintegration of the State which it was desired to see strong, friendly and independent, the assumption of fresh and unwelcome liabilities in regard to one of its provinces, and a condition of anarchy throughout the remainder of the country.<sup>36</sup>

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35. Hui, *State Formation in Ancient China*, 1.

36. Martin Ewans, *Afghanistan: A Short History of Its People and Politics* (New York: HarperCollins, 2002), 97.

Thomas Barfield describes Afghanistan's continuing status as a rentier state, a state dependent on outside financing replacing internal taxation.<sup>37</sup> Historically, Afghanistan had financed the state through raids. Ahmad Shah Durrani, starting in 1748, raided India eight times, conquering the Mughals, taking Delhi and extracting significant revenue. The British, in the 19th century, alternated between a policy of subsidizing and warring with Afghanistan rulers. This resulted in Anglo-Afghan wars in 1839-1842, 1878-1880, and 1919 with outcomes unfavorable for the British. The Russian empire was a factor in the second war. British subsidies continued to establish a buffer territory around the “gem” of British India, until Afghan independence in 1919. During the 1930s Afghanistan again exploited great power rivalries by seeking aid from the Axis powers of Germany, Japan, and Italy to counter British and Soviet influence. The greatest Afghanistan payoff was from exploiting Soviet/American rivalries starting in the 1950s thereby obtaining support from both rivals. These funds modernized the Afghan army in the 1950s, constructed Afghan infrastructure in the 1960s, and educated Afghan youth in the 1970s. Significant numbers of Afghans were educated in the Soviet Union (engineering and science), and the United States (humanities and political science). These subsidies reached two-thirds of the budget by 1973. Barfield notes that, “The old strategic great game was paying rich new dividends, and Afghanistan became a rentier state.”<sup>38</sup>

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37. Thomas Barfield, *Afghanistan: A Cultural and Political History* (Princeton: Princeton University Press, 2010), 121.

38. Ibid., 205.

The preceding key readings that have informed my thesis provide the state specific factors that evolve a general fragile state model into a model capable of encompassing the broad range of internal (endogenous) and external (exogenous) factors specific to Afghanistan. There is no standard state. The following section develops the economic, political, security, and social factors of states. This is followed by a section that develops the agent-based modeling approach to apply these factors.

## CHAPTER 3

### Economic, Political, Security and Social Factors of States

Little else is requisite to carry a state to the highest degree of opulence from the lowest barbarism, but peace, easy taxes, and a tolerable administration of justice; all the rest being brought about by the natural course of things.

Adam Smith lecture<sup>39</sup>

Adam Smith provides a succinct summary of the causal factors driving Acemoglu and Robinson's virtuous circle in Figure 8. These factors are also consistent with Hui's self-strengthening reforms and self-weakening expedients, developed below.

The literature on fragile states is broad, encompassing both qualitative case studies and quantitative studies examining greed and grievance as mechanisms to failed states. My thesis emulates Paul Collier's approach of developing a general model and exploring model fit against case studies of individual states and uses Collier's dataset.<sup>40</sup> Although much of the theoretical justification for the model is credited to Acemoglu and Robinson, the application is strongly influenced by Hui's work on dynamic models contrasting European state formation in the early modern period (AD 1495 – 1815) to China in the Spring, Autumn, and Warring States periods (656-221 BC).<sup>41</sup> Hui's work counters three illusions of eastern versus western states and provides empirical support to dynamic models of state relations and evolution. The illusions are; 1) that China was destined for authoritarian rule under a unified empire, 2) that sovereign state interactions are dominated by "balance of power," and 3) that this mechanism is a strictly western concept.

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39. Adam Smith, lecture in 1755, quoted in Dugald Stewart, *Account Of The Life and Writings of Adam Smith LLD*, Section IV, 25. <http://www.adamsmith.org/quotes> (accessed February 23, 2014).

40. Paul Collier and Nicholas Sambanis, eds., *Understanding Civil War: Volume 2: Europe, Central Asia, and Other Regions* (Washington D.C.: The World Bank, 2005).

41. Acemoglu and Robinson, *Why Nations Fail* and Hui, *State Formation in Ancient China*.

Contrary to both eastern and western scholarship, according to Hui, China was not destined as a unified empire under autocratic rule. During the Spring, Autumn, and Warring States periods (656-221 BC) China was composed of numerous states in a greater struggle for survival through balance of power than the early modern period (AD 1495 – 1815) of European states. Contrary to the European experience, major Chinese states were conquered and absorbed. The state-society bargaining with the population, which insured state survival through war, created individual rights in both Europe and China during these periods. Hui develops this idea:

It is often presumed that this foundation for liberal democracy is unique to Western civilization and alien to non-Western cultures. From the perspective of comparative history, it is of critical importance that China was once a system of sovereign, territorial states in the classical era. As with the European experience, intense international competition gave rise to citizenship rights understood as recognized enforceable claims on the state that are by-products of state-society bargaining over the means of war. To motivate the people to fight and die in war, ambitious rulers made three major concessions: first, freedom of expression, as testified by the “Hundred (meaning many) Schools of Thought”; second, the right of access to justice and the right of redress before higher judges; and, third, economic rights in terms of land grants and welfare policies. Hence, citizenship rights in fact blossomed on Chinese soil long before they blossomed on European soil.<sup>42</sup>

Hui's conception of self-strengthening reforms and self-weakening expedients is developed with reference to Acemoglu and Robinson's virtuous and vicious circles provided in Figure 8. Building political institutional strength in ancient China by self-strengthening reforms involved the replacement of aristocracy with meritocracy in state service, the establishment of a standing army through conscription, replacing the noble warrior class, and the administration and imposition of direct and indirect taxes. Achieving these reforms required a bargain with citizens of freedom of expression and

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42. Hui, *State Formation in Ancient China*, 168.

the administration of justice.<sup>43</sup> The dire consequences of losing a war, the extinction of the state, created competition for the best administrators and generals. In this open environment intellectuals freely crossed borders seeking appointments in foreign states. Hui notes that “Marquis Wen of Wei, King Xian and King Xiao of Qin, King Wei of Qi, and other successful rulers were renowned for their ability to attract the best minds of the times.”<sup>44</sup>

Sufficient taxes to support large standing armies and healthy and motivated citizens for the army required inclusive economic reforms. The states of Wei and Qin divided land into grids awarding these to registered households, established granaries to cushion the effects of droughts and famine, and enhanced agricultural productivity. Agricultural productivity was increased through large irrigation projects, clearing wastelands, introducing multiple crops per year, and developing hybrid seeds.<sup>45</sup>

It is important to contrast these self-strengthening measures with Afghanistan and the period (AD 1495 – 1815) of European states. The previous section developed Afghanistan as a rentier state dependent on foreign contributions to fund the state and foreign militaries for security. During the early modern European period, states resorted to self-weakening expedients of foreign mercenaries in place of domestic armies, funding wars through loans versus taxes, tax farming, the sale of offices, and aristocracy versus meritocracy in state service.

A historical analysis of institutions reveals a spectrum of factors and setbacks in the transition and consolidation to democracy and the explosive economic growth that separated the west from the rest (Figure 6).

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43. Ibid., 31.

44. Ibid., 173.

45. Ibid., 171.

The spectrum of conflict shifted from interstate conflict to civil conflict that was nourished during the Cold War through arms and support from Cold War adversaries. Monty Marshall charts the steep decline in civil conflict (Figure 9) at the conclusion of the Cold War and cites declining funding and support for conflict by Cold War adversaries as the primary cause of this decline.

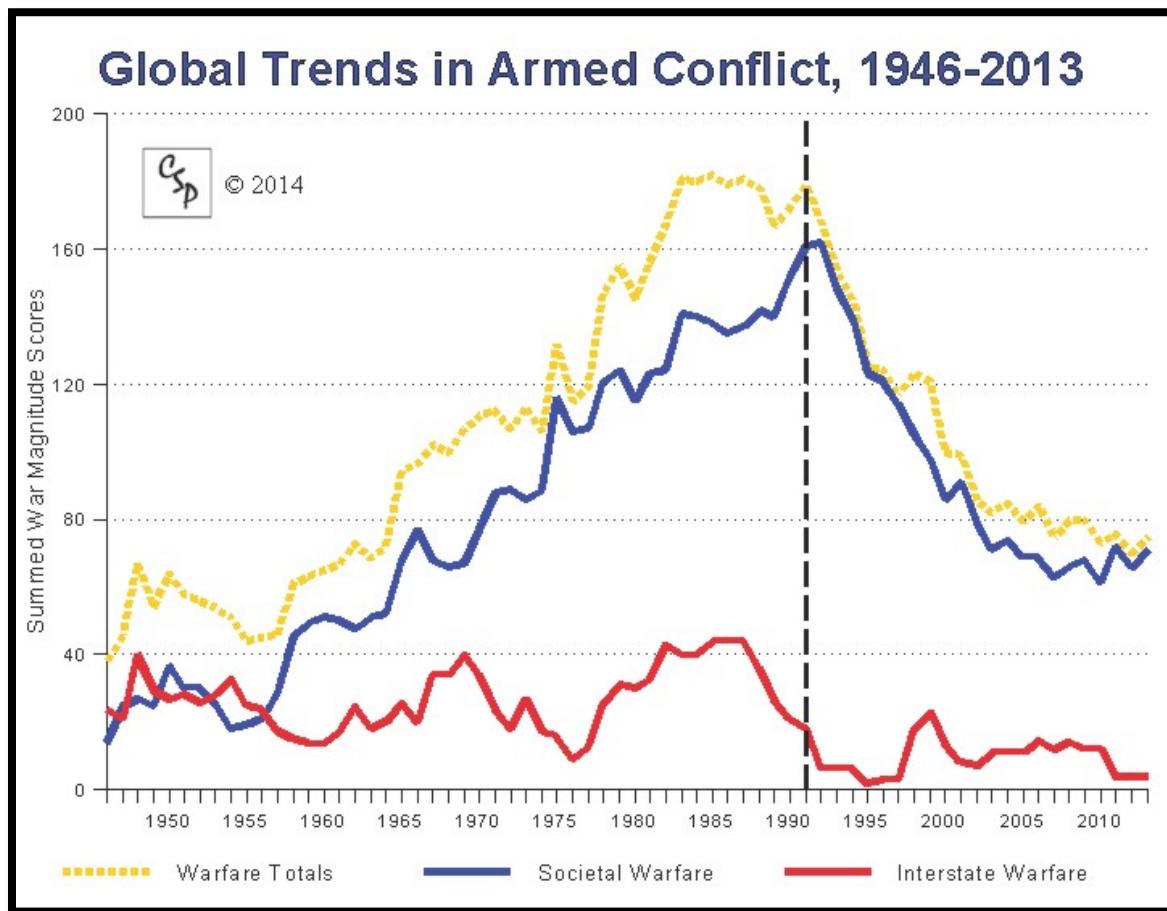


Figure 9. Global Trends in Armed Conflict, 1946-2013<sup>46</sup>

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46. Monty G. Marshall, and Benjamin R. Cole, *Global Report 2011: Conflict, Governance, and State Fragility* (Vienna, VA: Center for Systemic Peace, 2011), 10, <http://www.systemicpeace.org/CTfigures/CTfig03.htm> (accessed May 2, 2014).

My analysis of these factors is not the Realistic International Relations conception of states but the problematic character of the 122 states constituted after 1950 that compose 64% of all states. These new states create a cauldron of instability in Africa, Europe and the former Soviet Union and are the focus of this thesis's quantitative models of fragile states.

Barrington Moore attributes the “making of the modern world” to conflicts among the top tiers of society.<sup>47</sup> A modern term for the middle class agitators is social entrepreneurs. Moore's description of the French Revolution emphasizes this point and places the role of peasants in perspective.

French society broke apart from the top downward as the monarchy, for institutional and personal reasons, became increasingly unable to control the divisive forces . . . The collapse increased latent discontents among the lower classes . . . Peasant uprisings . . . occurred in 1639, 1662, 1664, 1670, 1674, and 1675. By itself, popular resentment could not make a revolution. . . . only when popular grievances could coalesce even briefly with those of more powerful groups would they help to bring the monarchy crashing down amid fire, blood, and smoke.<sup>48</sup>

Today, the high education levels and long periods of residency in the West of terrorists support this perspective. Acemoglu and Robinson pay tribute to the foundational work of Moore through the title of their quantitative study on dictatorship and democracy.<sup>49</sup> I draw on their work and the foundational work of Collier and Hoeffler on greed and grievance to develop driving factors for fragile states.<sup>50</sup> A narrative for the factors employed in the thesis's model is developed below.

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47. Barrington Moore, Jr., *Social Origins of Dictatorship and Democracy: Lord and Peasant in the Making of the Modern World* (Boston: Beacon Press, 1993), 70.

48. Ibid., 70.

49. Acemoglu and Robinson, *Economic Origins of Dictatorship and Democracy*.

50. Paul Collier, and Anke Hoeffler, *Greed and Grievance in Civil War* (New York: The World Bank, 2002), <http://economics.ouls.ox.ac.uk/12055/1/2002-01text.pdf> (accessed February 23, 2014).

The trends of the last 25 years are the strong movement towards democratic governance, the marked relative decrease in inter-state warfare, and the strong decline of all conflicts from 1990 (Figure 10). Conflict now centers on societal warfare (Figure 9). This conflict is in fragile states concentrated in Africa and South Asia (Figure 3). Africa is a serious concern, because, as noted earlier, of the 46 countries in Africa, 20 (43%) are classified as high or highest risk in Peace and Conflict 2012.

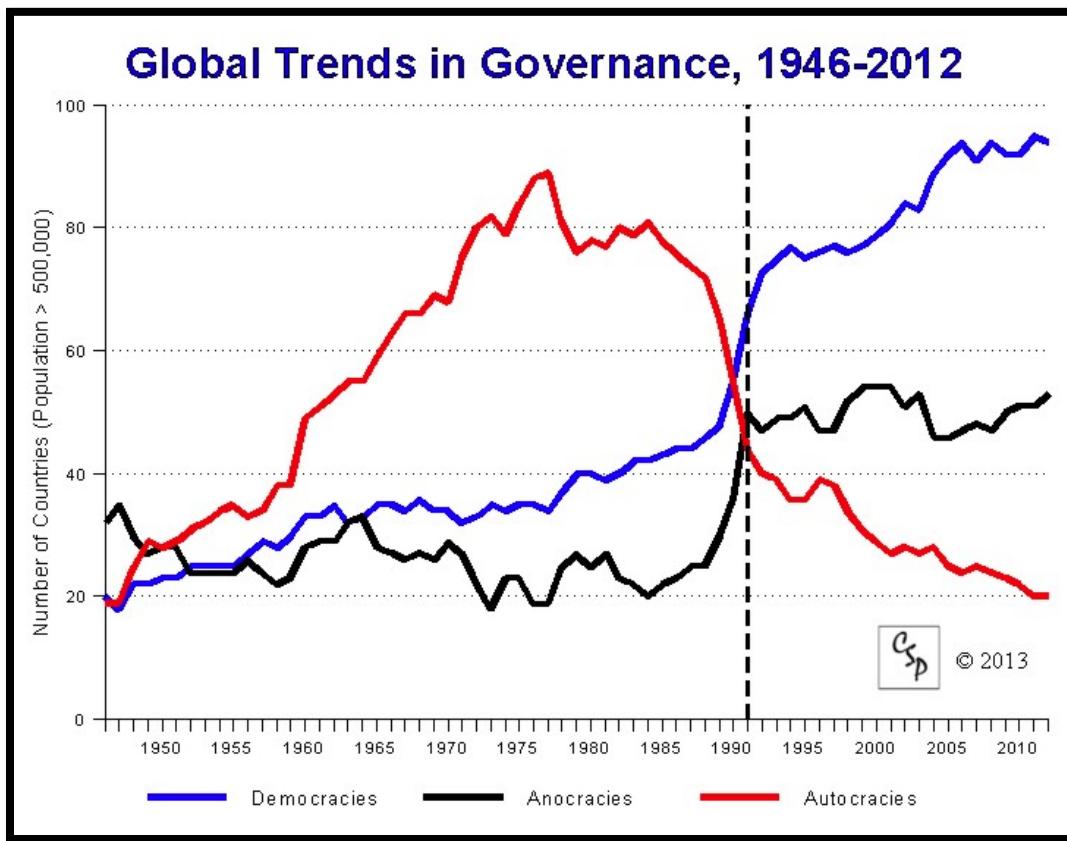


Figure 10. Global Trends in Governance, 1946-2012<sup>51</sup>

Drawing again from Acemoglu's virtuous and vicious circles (Figure 8) countries have a propensity to move towards both inclusive or both exclusive institutions. This creates virtuous or vicious circles. In a virtuous circle, inclusive political and economic

51. Marshall, and Cole, *Global Report 2011*, 10.

institutions constrain corruption and cronyism leading to greater income per capita.

Figure 11 displays log GDP (natural logarithm of Gross Domestic Product) per capita in dollars by state. The divergence is apparent when the natural logarithm of GDP on the y axis is translated to GDP using the relationship  $GDP = \text{exponential}(y)$ . Thus 10 equates to a GDP of \$22,026, 9 to \$8,103, 8 to \$2,981, 7 to \$1,097, and 6 to \$403. This chart demonstrates the strong correlation between the control of corruption and income. Furthermore, the countries most effective at controlling corruption all have inclusive economic and political institutions. Conversely, exclusive political and economic institutions encourage corruption, rent seeking, and exploitation of the many by the few, resulting in no innovation and a spiraling decrease in income. This behavior also contributes to the instability of transitions from autocracy to democracy.

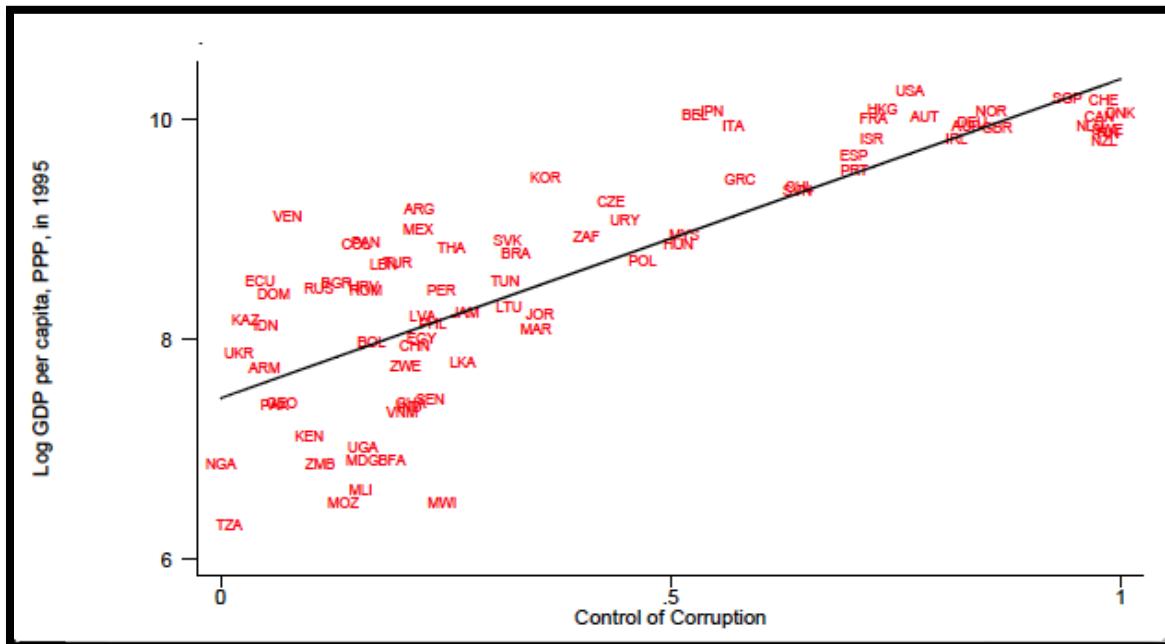


Figure 11. Control of Corruption, Log GDP per capital<sup>52</sup>

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52. Acemoglu, “Understanding Institutions lecture”.

Acemoglu's theory on the formation of democracy provides the dynamic factors necessary for constructing an agent-based model. Following is a summary of his arguments delivered in a series of lectures in Leuven in 2005.<sup>53</sup>

Elites control autocracies (de jure power), although citizens can sporadically exercise power (de facto power) through disturbances and protests. Possible elite responses to these disturbances are either 1) repression, 2) concessions within current governance, or 3) democracy. Figure 12 arrays the cost of repression against inequality segmented into three regions with representative countries placed in the regions. Democracy results when the cost of repression is great and concessions are viewed by citizens as not credible (Region B – Tunisia). The cost of repression is its effects on the wealth of the elite. In industrial societies dependent on the skilled labor of the middle class, the complex process of capital formation and international trade repression can destroy elite wealth, thereby enhancing the prospects for democracy. Industrialization also creates less inequality in these societies. Therefore; repression is more likely in agricultural and undeveloped economies (Region C – Libya). However; in societies providing sustainable income to citizens the threat of revolution may never arise to induce democracy (Region A – Saudi Arabia).<sup>54</sup>

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53. Daron Acemoglu, “Emergence and Consolidation of Democracy” (Gaston Eyskens Lectures, Leuven 2005. Lecture 4). <http://economics.mit.edu/files/1067> (accessed February 23, 2014).

54. The authors are strictly addressing economic motivations, not political, in this example.

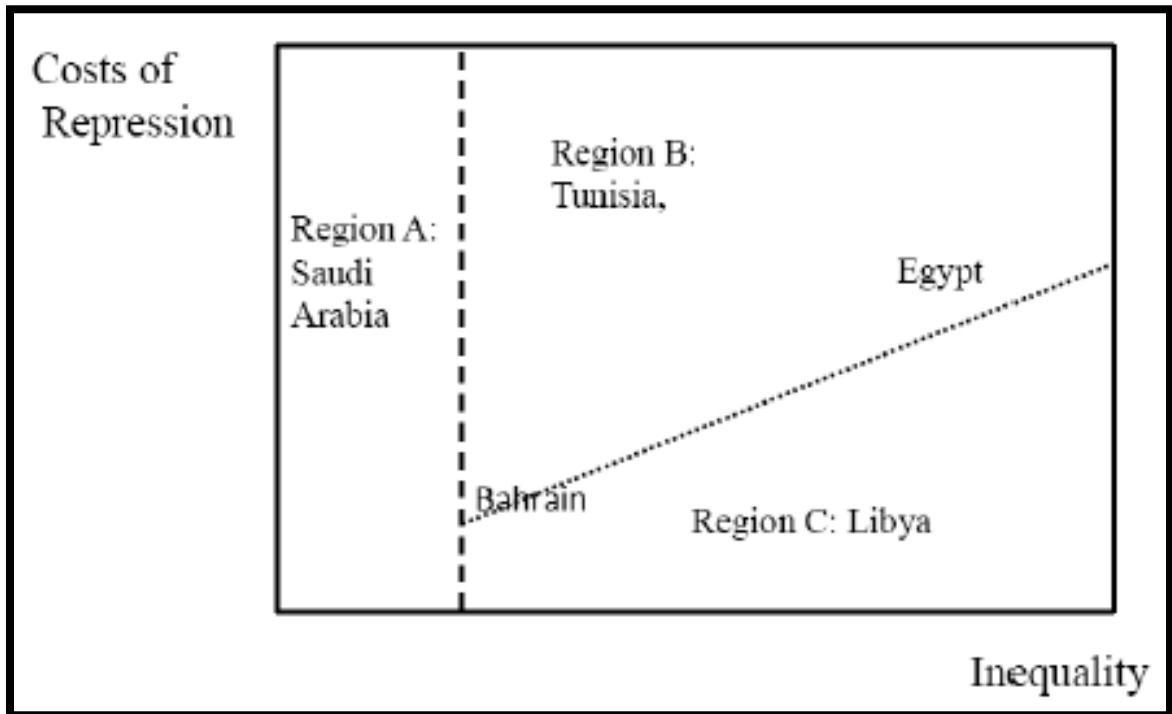


Figure 12. Cost of Repression<sup>55</sup>

In an equitable society the demand for democracy may be low because of lack of citizen action, but once democracy is attained, there is a high probability it can be consolidated. However; if coups are not costly to groups opposed to democracy, there is risk of cycling between democracy and dictatorship (right middle and lower side of chart). Remaining is the “sweet spot” for formation and consolidation of democracy are states with mild inequalities and industrial development.

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55. Acemoglu, “Why Nations Fail lecture,” 8.

Supplementing these factors is the foundational work on the economic drivers of civil conflict from Collier and Hoeffler's work at the World Bank.<sup>56</sup> This work discusses the security implications of resources, arms, and the deadly combination of the Cold War. Their work supports the claim that important factors enabling civil conflict are lootable resources and shielding terrain (forests and mountains). Sparsely populated forests or mountains provide refuge for revolutionaries. Previously discussed were the surrogate measures for social services and political cooperation, infant mortality rates, and discrimination.

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56. Collier, and Hoeffler, *Greed and grievance*.

## CHAPTER 4

### Intelligence Indicators and Warnings of State Failure

The economic, conflict casualties, and humanitarian consequences of failed states is of such concern that organizations, such as the Fund For Peace and The Center for International Development and Conflict Management (CIDCM), and the Center for Systemic Peace provide indicators on fragile states. As noted, the Political Instability Task Force (PITF) maintains a dataset on state failure. Some of the most highly regarded analysis of the root causes and paths out for failed states is sponsored by The World Bank with contributions from Collier, Hoeffler, Sambanis and Fearon.<sup>57</sup> All these authors are widely cited for their works on civil conflict. Additionally, the Harvard Failed States Project under the direction of Rotberg engaged over forty scholars and practitioners from 1999 to 2001 and produced two books of case based analysis on individual states.<sup>58</sup>

The intelligence and policy motivation for these indicators is described by Monty G. Marshall:

Early warning systems capable of alerting policymakers to impending state crises are a desirable innovation in the management of international engagement. Political action, however, is not a mechanical system but rather a complex, adaptive system based on conditional, strategic interaction. Early warning systems, in this application, must be designed to assess change in the principal conditions that affect strategic considerations, that is, by measuring the relative risk of state crisis or instability.<sup>59</sup>

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57. Collier and Hoeffler, *Greed and grievance*, 563-595; and Paul Collier and Nicholas Sambanis, eds. *Understanding Civil War: Evidence and Analysis*, Vol 2, (Washington D.C.: World Bank, 2005); and James D. Fearon, *Governance and Civil War Onset* (New York: The World Bank, 2011).

58. Rotberg, *State Failure In a Time of Terror*.

59. Monty G Marshall, *Fragility, Instability, and the Failure of States: Assessing Sources of Systemic Risk* (New York: Council on Foreign Relations, 2008), <http://www.cfr.org/conflict-prevention/fragility-instability-failure-states-assessing-sources-systemic-risk/p17638> (accessed February 26, 2014).

The previous paragraph outlines the demands on intelligence and policymakers in the real world. However, in a complex adaptive system our actions and policies influence the actions and policies of our adversaries and allies. Also, as noted by the British Department of International Development (DFID), intervention can have unintended and pernicious effects. The ability of an agent-based model to generate scenarios and account for exogenous factors, such as outside intervention, elevates the utility of these models above simple statistical prediction. However simple statistical models have demonstrated significant fit in signaling future instability in a state two years in advance of its instability. Both the CIDCM Peace and Conflict 2012 and the Center for Systemic Peace State Fragility Index 2012 use logistics regression to predict the probability of future conflict. The Political Instability Task Force (PITF) model, discussed below, claims the ability to predict onsets of violence within the following two years with 80% accuracy using only four independent variables.<sup>60</sup> This claim is investigated in the Methodology Section.

The PITF instability model has evolved from empirical research by a wide range of contributors over the last 15 years. The discussion of the explanatory variables below comes from their paper on the model.<sup>61</sup> Model construction using logistic regression is developed in the Research Methodology and Model Development Section and in the Appendix.

**Regime Type:** The largest explanatory factor in many models of civil wars has proven to be type of government. This is the largest contributing factor in the PITF

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60. Goldstone et. al., *Forecasting Political Instability*, 190-208.

61. Ibid.

model, which uses the Polity IV dataset to represent government type.<sup>62</sup> The Polity IV data series rates governance of independent states from 1800 to the present on a 21 point scale of -10 (autocracy) to 10 democracy. Polity IV characterizes an anocracy as a mixed form of government (mid-range of scale) dominated by autocrats but having some characteristics of democracy. The transition from autocracies towards mixed governance with elements of democracy (anocracies) has been found particularly unstable (Figure 13). The figure demonstrates that the annual likelihood of a major democratic transition, adverse regime change or the onset of political violence is significantly more likely in an anocracy versus either an autocracy or democracy.

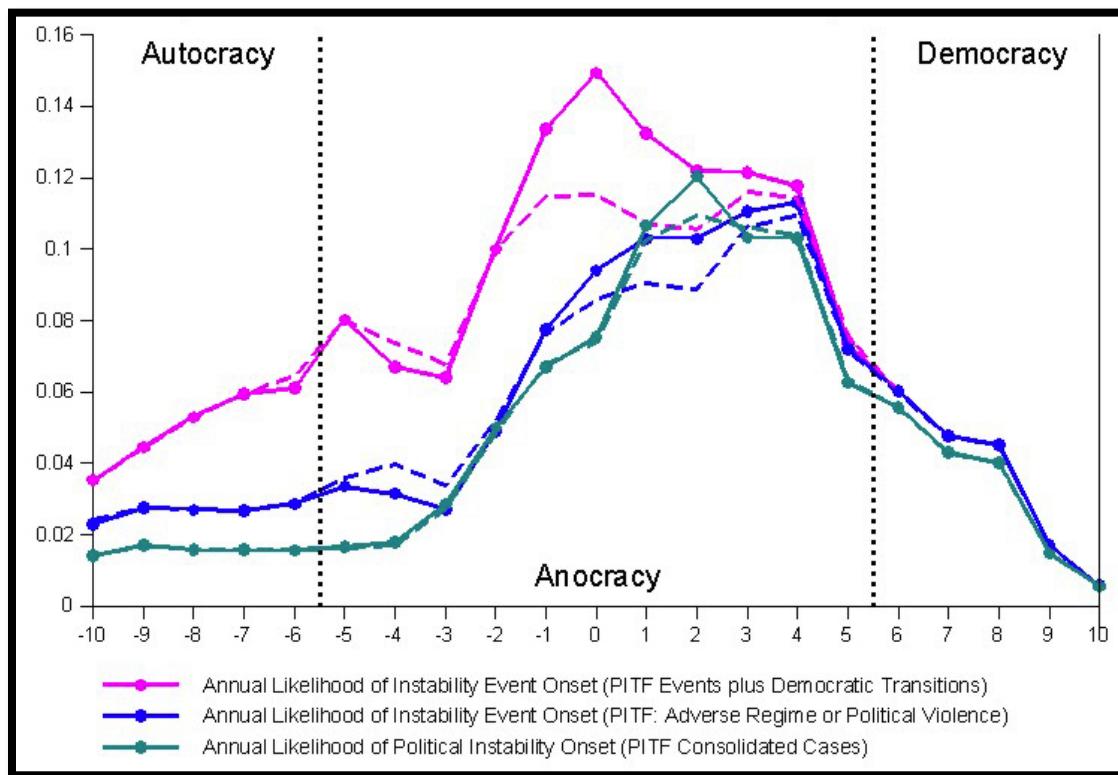


Figure 13 Instability of mixed forms of Governance (anocracies)<sup>63</sup>

62. Monty G Marshall. and Keith Jagers. 2002. *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2002* (College Park, MD: Center for International Development and Conflict Management), <http://www.cidcm.umd.edu/inscr/polity/index.htm>, (accessed February 26, 2014).

63. Ibid., 1.

Polity IV is based on five attributes: 1) competitiveness of executive recruitment; 2) openness of executive recruitment; 3) constraints on the executive; 4) regulation of political participation; and 5) competitiveness of political participation. The PITF model does not use the 21 point linear scale, but rather it combines two attributes, openness of executive recruitment and competitiveness of political participation into a non-linear measure. This permits the model to differentiate the risk of instability between five classifications of governance: 1) full autocracies; 2) partial autocracies; 3) partial democracy with factionalism; 4) partial democracy without factionalism; and 5) full democracy.<sup>64</sup> The model calibrates the relative measure of political instability against governments that are full autocracies as the baseline. Full autocracies are authoritarian monarchies, dictatorships, and one-party states (Saudi Arabia, North Korea, and China are examples). Interestingly, autocracies such as North Korea, Syria, and Azerbaijan bear some resemblance to historical absolute monarchies with dynastic succession to mitigate succession crisis. Partial autocracies hold competitive elections for national office but control or restrict participation (Singapore and apartheid-era South Africa are examples). Partial democracies choose the executive through competitive elections with political competition; however, the elections are not free and fair or political participation is restricted (Venezuela in the Chavez era). The PITF data indicates that factionalism and partial democracy is the most unstable combination. Factionalism results from uncompromising blocks intensely pursuing conflicting interests, often resulting in mass mobilization (Venezuela in the 2000s and Thailand prior to the 2006 military coup are examples of partial democracies with factionalism). This government type has a 36 times

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64. Goldstone et. al., *Forecasting Political Instability*, 190-208.

greater risk of political disturbance than an autocracy.<sup>65</sup> Full democracies combine free and fair elections with open and institutionalized political participation (all OECD countries and a few developing countries such as Costa Rica and Uruguay are examples).

**Infant Mortality Rates:** This is a widely collected and studied measure that serves as a proxy for a country's equitable economic development, social welfare, and its capacity to deliver citizen services. This measure is typically normalized against the population permitting a per citizen comparison. Neither weak nor fragmented states possess the capacity, or desire in the case of weak states, to report economic and social welfare statistics. States at the 75 percentile (having infant mortality rates greater than 75% of all states) have a risk of political disturbance 15 times greater than the benchmark (full autocracies).<sup>66</sup>

**Conflict in 4+ Neighboring States:** Conflict in contiguous states has a propensity to spread as discussed previously and shown in Figures 1 and 2. Although conflict in 4 plus neighboring states appears extreme, 11 of the conflict onsets were in such states which represent nearly 10% of onsets. This factor increases the potential for crisis 22 fold.<sup>67</sup>

**State Led Discrimination:** The model has an indicator of state sponsored economic or political discrimination against ethnic or religious groups. When states exercise this discrimination the risk of civil war increases by a factor of 3 over the baseline.<sup>68</sup>

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65. Ibid.

66. Ibid.

67. Ibid.

68. Ibid.

Marshall charts the steep decline in civil conflict (Figure 9) at the conclusion of the Cold War and cites declining funding and support for conflict by Cold War adversaries as the primary cause of this decline. In addition, greed or grievance is the key factor differentiating fragile states models. Models focused on greed originated with Collier and Hoeffer in a study undertaken for The World Bank, and focus on the economic incentives and opportunities presented by resources to finance conflict.<sup>69</sup> In contrast, grievance models focus on ethnic and religious factionalism, government legitimacy, and the capacity of the state to provide social services.<sup>70</sup> Epstein's agent-based model on civil violence, a grievance model, is discussed in the next section.<sup>71</sup> The third approach to modeling is simple statistical fit employing logistic regression and is discussed in the Research Methodology Model Development Section. The PITF model, discussed previously, is an example of a simple statistical fit model. The model that this thesis develops is an agent-based model using a combination of greed and grievance and is highly influenced by the work of Acemoglu and Robinson.<sup>72</sup>

Marshal, using the terminology of complexity, develops the broad trend towards democratization and moderating conflict in four cascading waves: South America beginning in the 1970s, Eastern Europe in the 1980s, the collapse of communism in the 1990s, and, currently, the Arab Spring.<sup>73</sup>

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69. Collier and Hoeffer, *Greed and grievance*, 563-595.

70. James D. Fearon and David Laitin, "Ethnicity, Insurgency, and Civil War," *American Political Science Review*, Vol. 97 no. 1, February 2003: 75-90.

71. Epstein, "Modeling civil violence."

72. Acemoglu and Robinson, *Economic Origins*.

73. Marshall and Cole, *Global Report 2011*, 16-18.

Statistical models have a significant limitation in transforming warning on fragile states into actions that affect the trajectory of failure. These models do not account for external events, nor can they forecast the effects of current economic, political, or social disturbances. As a result, such models preclude important alternative analysis of US intelligence, military, or policy interventions. The World Development Report 2011 outlines the impact of external factors in Figure 14.

**TABLE 1.1 Security, economic, and political stresses**

Stresses	Internal	External
Security	<ul style="list-style-type: none"> <li>• Legacies of violence and trauma</li> </ul>	<ul style="list-style-type: none"> <li>• Invasion, occupation</li> <li>• External support for domestic rebels</li> <li>• Cross-border conflict spillovers</li> <li>• Transnational terrorism</li> <li>• International criminal networks</li> </ul>
Economic	<ul style="list-style-type: none"> <li>• Low income levels, low opportunity cost of rebellion</li> <li>• Youth unemployment</li> <li>• Natural resource wealth</li> <li>• Severe corruption</li> <li>• Rapid urbanization</li> </ul>	<ul style="list-style-type: none"> <li>• Price shocks</li> <li>• Climate change</li> </ul>
Justice	<ul style="list-style-type: none"> <li>• Ethnic, religious, or regional competition</li> <li>• Real or perceived discrimination</li> <li>• Human rights abuses</li> </ul>	<ul style="list-style-type: none"> <li>• Perceived global inequity and injustice in the treatment of ethnic or religious groups</li> </ul>

Source: WDR team.

Note: This table, although not exhaustive, captures major factors in the academic literature on the causes and correlates of conflict and raised in the WDR consultations and surveys.<sup>74</sup>

Figure 14. Security, economic and political internal/external factors<sup>74</sup>

74. The World Bank, *World Development Report 2011*, 7.

Unfortunately, these models are blind to beneficial transitions toward democracy. Both the Political Instability Task Force (PITF) database and the models are structured only to warn of the onset of political violence. As a consequence this approach fails to warn on beneficial non-violent transitions such as those of the initial stages of the Arab Spring. Historically, the database and models would also miss the 1989-1991 transitions in the Soviet Union and Eastern Europe. These limitations will be addressed in the Research Methodology and Model Development.

## CHAPTER 5

### Agent-Based Models

Treating national governments as if they were centrally coordinated, purposive individuals provides a useful shorthand for understanding policy choices and actions. But this simplification [reification] – like all simplifications – obscures as well as reveals. In particular, it obscures the persistently neglected fact of government: the “decisionmaker” of national policy is obviously not one calculating individual but is rather a conglomerate of large organizations and political actors.<sup>75</sup>

The introductory quote by Graham Allison and Philip Zelikow represents one of the strengths of agent-based models, i.e., the ability to explicitly model the constituent elements of a state, thus allowing these entities to evolve through interactions among the internal constituents, external states and external factors. This permits the simulation of dynamic behavior through simple models of agents who possess attributes and interact with other agents. Often unexpected emergent macro level behavior emerges from these interactions.

Neil Johnson characterizes the attributes of complexity that agent-based modeling addresses.<sup>76</sup> First, there are many agents, a crowd, and the heart of most models is competition for some limited resource. This can be tangible, such as the division of the economic spoils between elites and citizens, or intangible, such as the level of political grievance against the state. Second, the agents interact locally with realistic limits on what they know. Third, agent behavior and interactions evolve uncertainly through time without central control. The result is emergent behavior, i.e., behavior not predictable from attributes of individual agents. Emergent behavior in Epstein's civil violence agent-

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75. Graham Allison, and Philip Zelikow, *Essence of Decision: Explaining the Cuban Missile Crisis*, Second ed. (New York: Longman, 1999), 3.

76. Neil Johnson, *Simply Complexity: A Clear Guide to Complexity Theory* (Oxford: Oneworld Publications, 2007).

based model, described below, is the masking of grievance for extended periods, the efficacy of curfews and periodic spiked, revolutionary outbreaks.<sup>77</sup>

An agent-based model is a computer model executed on a space either representing the geographic and demographic attributes of a territory or a network of relationships. The agents represent people or groups with similar attributes. These agents are distributed across the space and endowed with attributes which includes preferences, how they receive information, and how they interact. One central concept is that agents modify their actions and preferences through mainly local information and interactions. Finally, agent placement and attributes are typically determined using probability distributions which create multiple versions of the future. The space on which agents interact is represented by various topologies dependent on whether it models real territories or simple group network interactions (Figure 15). These topologies include: a) chessboard, b) two-dimensional (2D) or three-dimensional space (3D), c) networks, d) geography (may include features such as cities, mountains, and rivers), or e) abstract space.

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77. Epstein, “Modeling civil violence.”

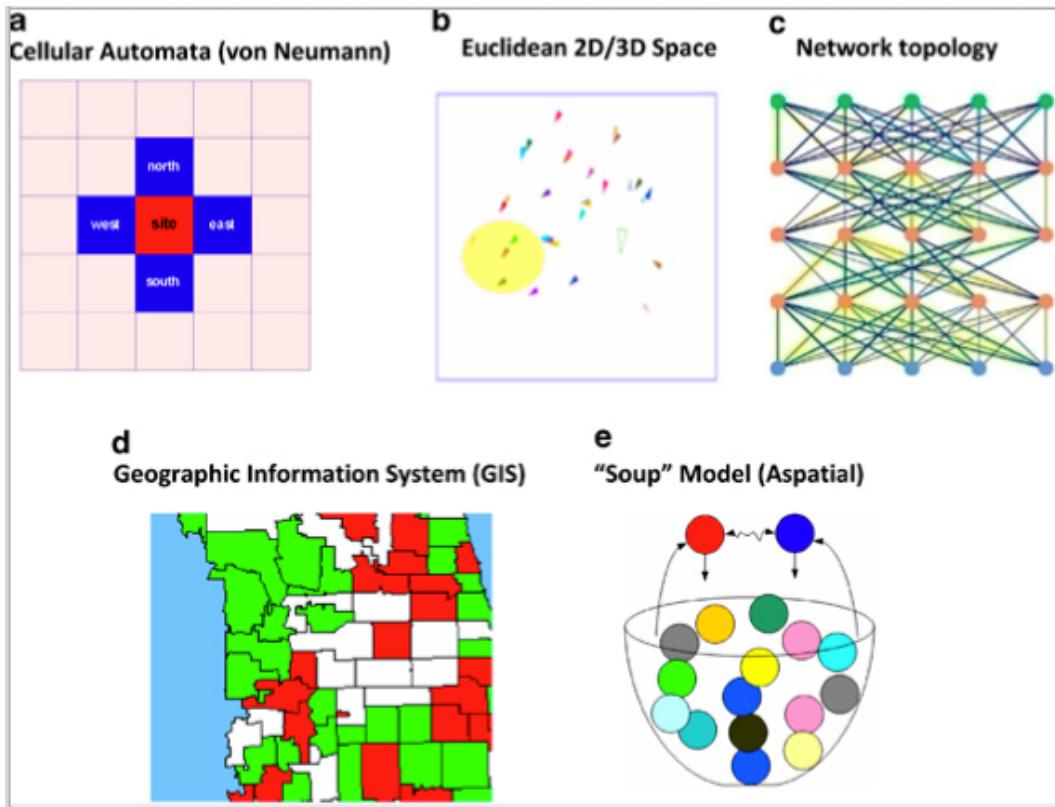


Figure 15 Agent Topologies<sup>78</sup>

I use Epstein's civil violence model to illustrate the principles outlined above.<sup>79</sup>

Epstein uses two types of agents, citizens and cops. The citizens are heterogeneous because of their attributes, grievance and risk tolerance (of arrest), which are drawn from probability distributions. Both agents and cops move randomly across a state and have only local interactions and limited vision (bounded information). Citizens have two states, quiescent and rebellious. Citizens rebel when their grievance exceeds their risk tolerance times their probability of arrest. Therefore; the presence of cops influences the behavior of individual citizens or, said differently, citizens with high grievances mask them in the presence of cops. These simple micro-specifications for agents interacting

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78. Charles Macal and Michael North, "Agent-Based Modeling and Simulation", (Proceedings of the 2009 Winter Simulation Conference), 94, <http://www.informs-sim.org/wsc09papers/009.pdf> (accessed November 16, 2013).

79. Epstein, "Modeling civil violence".

locally with bounded information produce surprisingly complex macro behavior. Agents mask their grievance in neighborhoods with many cops, assemblies of potentially rebellious citizens reduce the probability of arrest for individual citizens, and rebellious breakouts are cyclic and dependent on how fast grievances change.

Agent-based modeling, unlike most analytical approaches, is not based on equilibrium considerations. For example, the concept of Nash equilibrium applied to game theory is widely applied in economics.<sup>80</sup> Nash Equilibrium is a specification that selects competitive positions for each player in a game that deteriorates with any incremental change by any of the parties. However; rising computation capability has led to the growth of complexity analysis and non-equilibrium physics has ameliorated the “necessary condition” of equilibrium in model development. The world does not appear to be in equilibrium for most of the time, and if equilibrium exists it may take an extraordinary time to get there.

Three simple examples of problems where agent-based models have contributed to understanding may be helpful in showing their value.<sup>81</sup>

Agent-based models have been successful at simulating flows. Models are successful in predicting traffic jams, the persistence of congestion and the severe effects even on traffic moving in the opposite direction. Agent-based models are an ideal fit because individual drivers are endowed with differing driving attributes, and interaction is local. The macro behavior of traffic jams and persistence of congestion is called

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80. David M. Kreps, *Game Theory and Economic Modeling* (Oxford: Oxford University Press, 2009).

81. Eric Bonabeau, “Agent-based modeling: Methods and techniques for simulating human systems”, *Proceedings National Academy of Sciences*, vol 99, May 14, 2002, <http://pnas.org/cgi/doi/10.1073/pnas082080899> (accessed October 26, 2013).

emergent behavior because it results from simple specifications on the individual agents and their local interaction.

Agent-based models have also been successful at simulating the spread of contagion. This contagion can be biological or social. An agent-based model can represent a clique or network of groups or people and model communication, altered states, immunization, and cascading change.

Finally, agent-based models have been successful at simulating stock markets and the complex behavior of herding and price volatility, causing instabilities.

The value of agent-based models is not simply derived from intensive computation. Schelling, with paper and pencil, constructed what can be considered the first agent-based model explaining the emergence of segregated neighborhoods in the absence of deep prejudice. The model used simple rules for agents (people) yet still resulted in macro phenomena.<sup>82</sup> This is the ideal quest of economists, to explain macro results from micro behavior.

R. L. Axtell, Epstein and their colleagues were challenged by the Santa Fe Institute to model the next century using complexity and agent-based models. They quickly realized that agent-based modeling approaches could not be validated on another prognostication of the future. The model must first be fitted to historical data before being used as a forecasting tool. The team decided to model the emergence and sudden disappearance of the Anasazi from Long House Valley (Arizona) from 800 to 1350.<sup>83</sup>

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82. Thomas C. Schelling, “Dynamic Models of Segregation,” *Journal of Mathematical Sociology* 1971, Vol. 1, 143-186, [http://www.stat.berkeley.edu/~aldous/157/Papers/Schelling\\_Seg\\_Models.pdf](http://www.stat.berkeley.edu/~aldous/157/Papers/Schelling_Seg_Models.pdf) (accessed October 26, 2013).

83. R. L. Axtell et al, “Population Growth and Collapse in a Multi-Agent Model of the Kayenta Anasazi in Long House Valley,” *Proceedings of the National Academy of Sciences*, 99(30) (May 2002): 7275-7279, [http://www.pnas.org/content/99/suppl\\_3/7275.full](http://www.pnas.org/content/99/suppl_3/7275.full) (accessed February 26, 2014).

Agents represented families and their agricultural capacity given the bleak environment of periodic droughts, the unstable water table, and the capacity of yearly food stores. Archeologists had made extensive studies of the area determining the dynamic growth and decline of family units and drought history. The Axtell group formulated micro factors on family formation and agriculture practices constrained by the land's carrying capacity derived from environmental factors. The model is widely cited in the literature for "fitting" history with an agent-based model. Axtell, using sum of least squares (employed in regression), simply selected the "history" best fitting the data. In the Research Methodology and Modeling Section, this suspect methodology is discussed. Most importantly, agent-based models use stochastic factors, drawn from probability distributions, to generate alternate histories.

Cederman has used agent-based models to examine the emergence, evolution and death of states.<sup>84</sup> International relations theory during the Cold War was dominated by balance of power concerns and the corresponding tension between states. Established theory could not address or forecast the sudden disintegration of the Soviet Union, the fracture of Yugoslavia, or the unification of Germany. Cederman's Emergent Polarity model treats the number of sovereign states, as an emergent feature modeling the emergence and disappearance of states.

These examples were structured to ascend the ladder of complexity in building agent-based models. Although simple models consisting of agents constructed with a limited number of attributes and responses are successful at examining segregation and traffic jams, emulating historical situations requires a greater repertoire of attributes,

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84. Lars-Erik Cederman, "Endogenizing geopolitical boundaries with agent-based modeling," *Proceedings National Academy of Science*, vol. 99 (May 2002), <http://pnas.org/cgi/doi/10.1073/082081099> (accessed October 26, 2013).

behavior and the injection of exogenous factors (such as fluctuating occurrences of drought in artificial Anasazi). Admittedly, agent-based models have not reached the maturity of econometric models because they are infrequently used for forecasting. Current applications are more effective at providing theoretical understanding and examining the emergence of unexpected behavior. These include Cederman's evolution of states, and the Santa Fe Institute's artificial stock market which examines herding behavior and price volatility causing market instabilities.

Agent-based modeling is the ideal platform for demonstrating complex phenomena. Complexity is characterized by independent interconnected adaptive agents that interact locally with bounded information. Absent from this definition is any conception of equilibrium and constraints on how the agents utilize the bounded information to make decisions. The result of agent interactions is emergent behavior unpredictable from the information and decision making of the autonomous agents. This behavior varies from the segregated neighborhoods resulting from Schelling's model to the propagation and cessation of contagion in innovation or virus models. In the case of the Anasazi of Long House Valley it explains the growth and disappearance of a civilization.

Still equilibrium must be addressed since it has been the dominating principle of economics and classical physics and thus strongly influences any political or social models. Nash Equilibrium, micro foundations of economics, representative agent, First and Second Welfare Theorems, and Median Voter Theorem are mainstays of economics and political science.

Although Nash Equilibrium is the “best” in competitive situations, cooperation and trust often yield improved outcomes for all parties. In the case of micro foundations of economics, rational choice theory has dominated the discussion. However; over the last twenty years this bedrock economic assumption has been challenged by Nobel laureate Daniel Kahneman.<sup>85</sup> In the representative agent approach, all consumers or firms are generalized to one representative using rational choice with mostly limitless information. Agent-based models permit heterogeneous agents using bounded information employing multiple decision algorithms. Moreover; this broadening is consistent with contemporary economics. The cost and time to obtain information determines the information gathered, and people make decisions in other ways. The First and Second Welfare Theorems are the theoretical justification for Adam Smith's invisible hand and the guarantee that any optimal economic result can be restated as a competitive equilibrium. Business concentration and oligarchic behavior invalidates both of these results. Finally, the Median Voter Theorem specifies voter outcomes under certain practical restrictions. Nash equilibrium and Median Voter Theorem are employed in Acemoglu and Robinson's work.

The greatest challenge to equilibrium is twofold: 1) we are interested in the dynamic transformation in many political and social situations – this is certainly the case for fragile states, and 2) equilibrium may not be attainable in any practical time span.

Although the previous studies were conducted using different modeling languages, many have been translated as NetLogo models. NetLogo, through the efforts of Uri Wilensky at Northwestern University, is the lingua franca of agent-based modeling

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85. Daniel Kahneman, *Thinking Fast and Slow* (New York: Farrar, Straus and Giroux, 2011).

languages and can be downloaded from the referenced site.<sup>86</sup> NetLogo requires no computer programming skills, has a wide range of learning tutorials, and has translated a comprehensive number of models.

In summary, NetLogo is a modeling and simulation language capable of modeling natural and social phenomena over time. NetLogo has a large library of exploratory models which both inform model building and provide the core of many complex models. The language is available on many computer operating systems and can be executed across multiple computers.

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86. U. Wilensky, NetLogo. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL, <http://ccl.northwestern.edu/netlogo/>, (accessed February 26, 2014).

## CHAPTER 6

### Research Methodology and Model Development

My thesis addresses significant weaknesses of Realist International Relations when constructing the agent-based model. These weaknesses include the reification of the state into a permanent single-factor entity and state fractionalization, the dominant form of present conflict. Reification tends to ignore contending internal groups, thereby limiting the understanding of civil conflict.

My work develops a parsimonious statistical analysis supporting an agent-based model to develop alternative futures for fragile states. The model evolves alternate futures through its dynamic response to internal and external factors. My thesis then describes these futures with associated probabilities and highlights any extreme behavior. This analysis is limited to quantifying the probability and uncertainty of violence within a state but does not address the indicators and warning of impending violence. My agent-based model is formulated to capture the sharp discontinuity of an outbreak of violence and in the future provide indicators and warnings.

Definitions of key concepts follow:

***Alternative Futures*** permit policy makers to make assumptions about the likelihood and consequences of various events and scenarios. The formulation of estimative intelligence framed with the probability of multiple outcomes fulfills this need.

***Parsimonious Models*** employs the principle of Occam's razor, preferring simple explanations with few factors to complex explanations. An example is the Copernican sun-centered universe over the earlier Earth-centered system with epicycles.

**Stochastic** factors are non-deterministic and drawn from a probability distribution. They represent uncertainty regarding both understanding of the world and the uncertainty of the future.

**Regression** is an approach relating one or more independent variables to a dependent variable in a linear relationship, for example, a simple line with an intercept and slope for one dependent variable. The independent variables are explanatory and represent correlation. The value of the dependent variable is stated as a mean and a confidence interval. A 95% confidence level implies that with 95% certainty the dependent variable is within the confidence interval.

**Monte Carlo Analysis** is a modeling approach suitable for non-deterministic phenomena. For instance the function  $\{y = 3x\}$  is deterministic, once we have  $x$  we know  $y$ . However if we draw numbers from a probability distribution, the function  $(y = 3x + \{\text{probability draw}\})$  varies according to the number drawn. Monte Carlo methods acknowledge this uncertainty by generating many values for  $y$  by drawing many values from the probability distribution (several hundred usually). The Monte Carlo method then represents  $y$  by the probability distribution formed from hundreds of draws. Typically  $y$  is then stated as an average value surrounded by a confidence interval which encompasses a certain percentage of the generated values (95%, for instance).

The “secret” of economic and political forecasting is that most forecasts resemble the present. This is the bane of econometric models. Divergence from the present is often caused by unexpected external factors and cascading failure from factors linked through complexity and non-linearity. Unfortunately, these factors are not captured in most econometric models.

Models forecasting fragile states use simple statistical fit algorithms employing logistic regression. The PITF model, the CIDCM Peace and Conflict 2012, and the Center for Systemic Peace State Fragility Index 2012 all use a simple statistical fit logistic model. As a result these models have significant shortcomings for intelligence and policy work, because it is not possible to transform warning on fragile states into measuring the effects of proposed actions to affect the trajectory of failure. These models do not account for current external events, and cannot be used to model the effects of policy interventions or future external events. Most importantly, this precludes alternative analysis of US intelligence, military, or policy interventions. The *World Development Report 2011* outlines the importance of external factors such as the Cold War, economic shocks, conflict in neighboring states, criminal networks, climate, and disease (Figure 14).<sup>87</sup> These limitations are inherent in the construction of simple logistic statistical models.

Goldstone's paper describes the approach to logistic regression used to develop the PITF model.<sup>88</sup> This model uses only four explanatory variables to forecast onsets of instability two years in advance of the historical data. The fitness claimed is 80% accuracy in identifying both onsets of instability, and in identifying states that remain stable. The model achieves this balance by equalizing Type 1 (false positives – states erroneously identified for future instability) and Type 2 (false negatives – states not identified but experiencing future instability) errors. However, R Squared is not a suitable measure of fit for logistic regression (this is discussed in Appendix 1.1). Also, the paper did not validate forecasting accuracy by comparing past projections with actual

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87. The World Bank, *World Development Report 2011*.

88. Jack A. Goldstone et. al., "A Global Model for Forecasting Political Instability," *American Journal of Political Science*, Vol. 54, No 1, January 2010, 190-208.

results, the ultimate test of its validity. Furthermore; the objective is simply statistical fit through correlates and not the exploration of causal factors. There is no discussion or exploration of how these factors create pathways to instability. In contrast, Collier worked toward validating and expanding his model through case studies applied to a significant number of fragile states.<sup>89</sup>

Reification of states has such a commanding hold in this field that the PITF modeling approach was compared to biostatistics applied to cancer patients. The Goldstone paper describes the case control method they employed.<sup>90</sup> The logistical regression segregated analysis by region and year of comparison. Each country with a conflict onset in a given year was matched with three histories of countries drawn from the same year and same region. The three comparison histories were also selected to ensure stability in the two previous years and the succeeding four years. This approach eliminates the contribution of external factors that vary over time. Examining the history of conflict (Figure 9) demonstrates that this approach excludes the significant variation over 55 years of Cold War factors (significant Soviet or American arms and monetary support for states) and economic crisis. A biomedical analogy to this segmentation would be the exposure of one of the cohorts of cancer patients studied to significant external factors. This exposure would invalidate the case approach. The varying intensity of the Cold War created significant variation in external factors contributing to state instability. An implicit assumption of this case approach is that longitudinal data (data collected over 55 years) is comparable to cross-sectional data (data from multiple

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89. Paul Collier and Nicholas Sambanis, eds., *Understanding Civil War: Volume 2: Europe, Central Asia, and Other Regions* (Washington D.C.: The World Bank, 2005).

90. Jack A. Goldstone et. al., *Forecasting Political Instability*, 193.

cases over the same years). This assumption is invalid during the Cold War because of dynamic and widely varying factors over the years.

Contrasting with the equilibrium approach of Acemoglu and Robinson, agent-based models explore dynamic and unstable transitions as well as equilibrium. The advantage of combining econometrics with agent models is that once the model is constructed, alternate futures can be explored. Alternate futures are generated by the specification of factors through probability distributions, injecting current external factors, and constructing scenarios.

I object to the measures of fit employed in Epstein's Anasazi model. Each realization of the model developed a distinct history because factors were specified probabilistically. Epstein generated a large number of histories and simply plucked the run resembling the reconstructed history. This approach is not accepted in the standard approach to sampling plausible futures generated from probability distributions (the Monte Carlo method). Monte Carlo is extensively employed for financial risk analysis to forecast the future distribution of price for options and derivatives. The accepted Monte Carlo approach to specifying "futures" is to generate a large number of realizations using probability distributions for the inputs and describe attributes of interest through the resulting probability distribution. For example, our attribute of interest is a future instability event in a state. The distribution of this factor could be stated with an expected confidence level. For instance, from the statistical model for Afghanistan 2014 projections, with 68% certainty (one standard deviation) there is a 29% to 53% probability of violence over the next five years (see Figure 26).

The PITF database does not permit forecasting peaceful transitions because data on these events is not captured in one of the four categories of instability events.

According to Goldstone:

Peaceful transitions to democracy (involving fewer than 1,000 total deaths [per year]), as occurred after the death of Salazar in Portugal or Franco in Spain and in several of the post–Cold War transitions from communist regimes in Eastern Europe, are not counted as adverse regime changes. Neither is the peacefully negotiated dissolution of a federal union, as occurred in Czechoslovakia in 1993.<sup>91</sup>

My thesis has enumerated the following shortcomings in the current approach to forecasting fragile states. These shortcomings are: 1) exclusive use of simple logistic regression using R Squared to measure fit, 2) simply picking one realization of a model outcome, 3) not determining model parameters from a training set and validating the model against a dataset not encompassing the training set, 4) the use of slow moving factors for prediction, and 5) missing predictors for transitions to democracy like the Arab Spring. My model addresses each of these either in the implementation or recommended improvements in future efforts and represents the logical next step in forecasting fragile states.

Overcoming these shortcomings requires addressing four significant challenges in both the statistical analysis and the agent-based model for fragile states:

1. ***Identify leading indicators and indicators of peaceful transition to democracy.***

Current analysis on fragile states focuses on lagging indicators and fails to predict peaceful transitions to democracy (for instance some of the states in the Arab Spring).

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91. Ibid., 192.

2. *Discriminate the states for analysis.* This vastly improves the correlative and causal effects of indicators.
3. *Select an agent-based model capturing the non-linearity of the dynamics of fragile state transitions.*
4. *Interpret the agent-based model parameters and justify dynamic responses to change.*

## Model Development

The following discusses both the limitations of the Collier and PITF models and future approaches to overcoming the four significant challenges.

### 1) *Identify leading indicators and indicators of peaceful transition to democracy*

The first stage of developing my model for the thesis was to replicate the statistical findings of Collier’s “Beyond Greed and Grievance” (Chapter 7: Model Results and Alternate Futures).<sup>92</sup> Unfortunately, all the works discussed use lagging and slow moving indicators for dependent variables. Borrowing descriptive terms from econometrics, the goal is to construct the model using leading or predictive indicators, not lagging or slow moving indicators. Indicators in the current models are either not responsive to the precursors of instability, move too slowly, or are only measurable with unsatisfactory lags.

Slow-moving political and social factors from the PITF and Collier models are polity structure, infant mortality, diasporas in developed countries (a proxy for rebel financing), previous conflict, and years since last conflict. Slow-moving demographic and geographic factors are population dispersion by group (a proxy for a fractured state),

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<sup>92.</sup> Paul Collier, Anke Hoeffler, and Dominic Rohner, “Beyond greed and grievance: feasibility and civil war,” *Oxf. Econ. Pap.* (2009) 61 (1): 1-27.

urbanization (more stable), young males (potential soldiers), male secondary schooling (opportunity variable for potential soldiers), and geography (forests and mountains in which to hide). Slow moving economic factors are GDP (Gross Domestic Product) -- failed states are low-income, changes in GDP, and commodity exports/GDP (a proxy for rebel financing). Only state-sponsored discrimination (characterized by recent events), and greater than four conflicts in contiguous states change rapidly. However, greater than four conflicts (only 11% of the PITF states in conflict) appears to be an artificial measure dictated to optimize statistical fit.

Vito D'Orazio and James E. Yonamine have addressed this problem by identifying an event dataset, the *Global Database of Events, Language, and Tone* (GDELT), and formulating predictive indicators from this rapidly evolving event dataset.<sup>93</sup> Their approach employs a taxonomy of events and a method to aggregate events by month. GDELT is described by its founders as:

An initiative to construct a catalog of human societal-scale behavior and beliefs across all countries of the world, connecting every person, organization, location, count, theme, news source, and event across the planet into a single massive network that captures what's happening around the world, what its context is and who's involved, and how the world is feeling about it, every single day.<sup>94</sup>

Future refinements of my model will supplement the prediction variables with predictive indicators from rapidly evolving event data developed from the GDELT dataset. The resulting indicators are fine grained (daily) and can be formulated and improved to capture precursors to state instability. They are also not subject to the lags or distortions of official statistics. Closer to the concerns of my thesis, Yonamine has

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93. Vito D'Orazio and James E. Yonamine, "Kickoff to Conflict: A Sequence Analysis of Intra-State Conflict-Preceding Event Structures," (unpublished paper), [http://jayyonamine.com/wp-content/uploads/2012/04/Kickoff\\_to\\_Conflict\\_2.5.pdf](http://jayyonamine.com/wp-content/uploads/2012/04/Kickoff_to_Conflict_2.5.pdf) and the GDELT Event Database, <http://www.gdeltproject.org> (accessed April 30, 2014).

94. The GDELT Project: Global Database of Events, Language, and Tone, <http://www.gdeltproject.org> (accessed April 30, 2014).

employed event data (GDEL) on prediction of conflict at the district level in Afghanistan.<sup>95</sup>

Progress on predicting events like the Arab Spring, the disintegration of the Soviet Union and Yugoslavia, and the reunification of Germany require the addition of a PITF category for peaceful (towards democracy) transitions. This is both unplanned and a major undertaking. Transitions in the existing four PITF categories are sharply delineated by the occurrence of 1,000 deaths per year related to conflict. Peaceful transitions to democracy have no such delineation and would require determining a measure of radical yearly change in the Polity IV democracy index for a country.

## 2) Discriminate the states for analysis

After replicating Collier's results in Chapter 7 of this thesis (also Appendix 2.5), I examined two refinements addressing the serious effects of missing data and rare events on statistical analysis. Unfortunately, the countries most prone to violence are unable to report or distort the reporting of economic and social indicators. Even when the Collier dataset is augmented with World Bank estimates, it is still plagued by missing data. Collier used the standard approach to missing data by dropping the complete country year data from the analysis, thereby skewing the statistical analysis. I applied sophisticated imputation algorithms to estimate missing data (Appendix 2.7). Applying this approach, I identified problems with the predictive power of commodity exports and GDP. For several countries, one or both of these variables were missing values for the complete series from 1960 to 2005, thereby invalidating imputation.

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95. James E. Yonamine, "Predicting Future Levels of Violence in Afghanistan Districts Using GDEL," (unpublished paper), <http://jayyonamine.com/wp-content/uploads/2013/04/Predicting-Future-Levels-of-Violence-in-Afghanistan-Districts-using-GDEL.pdf> (accessed November 17, 2013).

Additionally, Nathaniel Beck, Gary King, and Langche Zeng have critiqued existing statistical approaches to the study of conflict and proposed an approach to discriminating the relevant data for analysis.<sup>96</sup> Effective warning requires predictive factors to differ for states at the onset of conflict. In the population of states an instability event is a rare occurrence. This rarity is compounded by the fact that for a large number of states instability never occurs. When statistical analysis is conducted on the full population of states, the correlated factors driving instability are barely distinguishable.

The PITF model addresses this through eliminating a large number of states from the analysis by randomly drawing three cohorts from peaceful states from the same region and over the same time. The limitations of this approach were previously discussed.

Beck, King, and Zeng outline an approach that my thesis adopts:

We address a well-known but infrequently discussed problem in the quantitative study of international conflict: Despite immense data collections, prestigious journals, and sophisticated analyses, empirical findings in the literature on international conflict are often unsatisfying. Many statistical results change from article to article and specification to specification. Accurate forecasts are nonexistent. In this article we offer a conjecture about one source of this problem: The causes of conflict, theorized to be important but often found to be small or ephemeral, are indeed tiny for the vast majority of dyads (two randomly selected countries), but they are *large, stable, and replicable wherever the ex ante probability of conflict is large*. This simple idea has an unexpectedly rich array of observable implications, all consistent with the literature.<sup>97</sup>

Simply stated, this approach identifies the states with high probability of conflict (ex ante probability of conflict is large) to emphasize their contribution to the explanatory factors. I have already assembled all the pieces necessary to adapt the Beck approach. Acemoglu's Figure 6 clearly differentiates states and regions by GDP. Many statistical findings have found strong correlation between GDP and state stability. Rotberg

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96. Nathaniel Beck, Gary King, Langche Zeng, "Improving Quantitative Studies of International Conflict: A Conjecture," *American Political Science Review*, Vol. 94, No. 1 (March 2000), <http://gking.harvard.edu/files/improv.pdf> (accessed November 17, 2013).

97. Beck, King, and Zeng, "Improving Quantitative Studies," 21.

documented the explosive formation of over 130 states (over 200% growth) since 1950.<sup>98</sup>

Newly formed states have a high potential for instability. Hewitt found the probability of an instability event for the top ten fragile states to be over 100 times the probability of occurrence in an OECD state.<sup>99</sup>

I applied the Beck approach to rare data in my thesis to clearly elicit the predictor values and to correct for bias in the estimate (in Appendix 2.11). Bias is correctible by explicitly coding the percentage of states experiencing conflict from a broader population. Despite rejecting the use of the broader population for imputation, this population was used to determine the percentage of states experiencing the onset of conflict (3 percent). The rare data approach lessens the predictive contribution of commodity exports to state instability.

### 3) *Select an agent-based model*

Complexity introduces nonlinearity, exhibits scale-free behavior, minimizes the importance of equilibrium, and magnifies the impact of small perturbations into sometimes extraordinary effects. All three models considered are nonlinear and represent complex behavior. From complexity, macro effects emerge from local interactions. My thesis considers three nonlinear models: the SIR (Susceptibles, Infectives, Removed with immunity) epidemic model, the Barabasi random scale free network, and percolation and renormalization theory. Both the Barabasi random scale free network and percolation theory clearly exhibit complex behavior as demonstrated by cascading failure, herding, and scale free behavior from local information and interactions. In contrast, the epidemic

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98. Rotberg, *When States Fail*. 2.

99. Center for International Development and Conflict Management, *Peace and Conflict 2012*.

differential equation model violates these constraints because contagion is globally, not locally, propagated.

The following arguments and approach are extracted from the Javorsek and Schwitz paper in *Intelligence and National Security*.<sup>100</sup> Outliers or rare events often confound the analyst and policymaker because they occur at a greater frequency than our intelligence products warn and they often dominate history. In physical processes there is increasing evidence that tracking small events signals the probability of catastrophes. Unfortunately, the Intelligence Community does not capture and analyze granular event data into intelligence products. The power of this approach is presented though analogous intelligence and national security concerns presented in Figure 16:

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100. Javorsek and Schwitz, “Probing Uncertainty.”

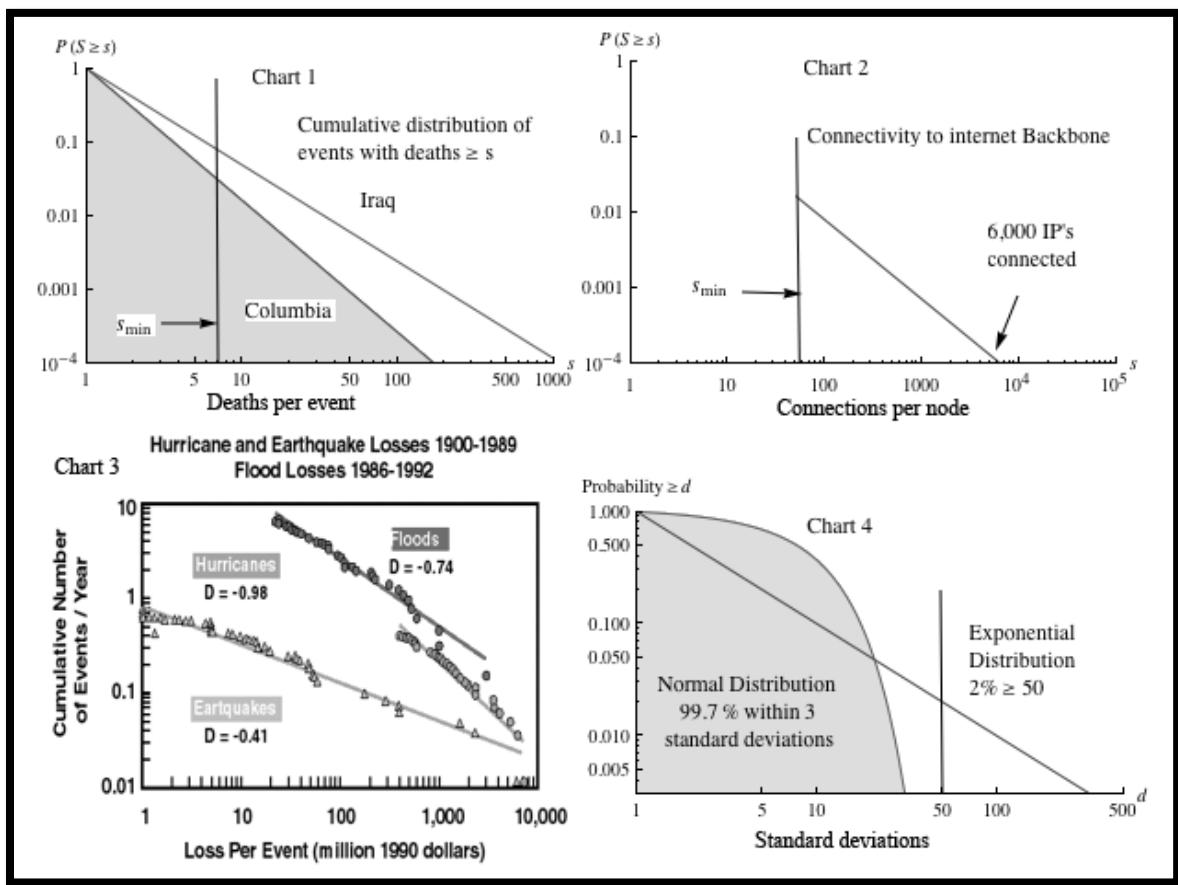


Figure 16. Casualties from conflicts, internet backbone connectivity, disaster, and tail risk<sup>101</sup>

101. Ibid., 6.

Javorsek and Schwitz have a detailed discussion of Figure 16:

The analysis encompasses casualties from terrorism in Columbia and Iraq, the internet backbone, national disasters, and the significance of ‘tail risk’. Complex processes drive this observed behavior, which is radically different from processes generated from distributions with finite variances. The papers referenced develop models to interpret trends and forecast future results. The detailed analytics are beyond the scope of this paper, so a brief summary suffices. Johnson develops models of terrorist behavior, its evolution, and the resulting casualties across a range of conflicts (Chart 1).<sup>102</sup> He also provides forecasting methods and indicators of progress in terrorist conflicts. Yan maps the connectivity of the internet backbone (Chart 2) and discusses the security risks from the highly connected nodes (the arrow points to 6000 IPs at one node).<sup>103</sup> His work uses network analysis, which is also used to study terrorist networks. Link analysis, examining the network connectivity of a terrorist network, is used to discover command and control relationships as well as identify methods of penetrating the network. The US Geological Survey (USGS) captures the frequency and severity of natural disasters (Chart 3), which is used to forecast economic and human losses, and provides the foundation for establishing rates and reserves in insurance.<sup>104</sup> Finally, the extraordinary behavior of exponential distributions on ‘black swans’ is evident from Chart 4, which describes the key characteristics of power law distributions.<sup>105</sup>

Because all charts in Figure 16 are on log/log scales they represent extraordinary behavior. Interpreting the relationship between the number of hurricanes (y axis) with a loss of less than x million dollars (x axis) demonstrates that the probability only declines by 1/10th as the loss from the hurricane increases 10 fold (see Chart 3). This relationship defines scale-free behavior and generates radically more large events than the normal distribution (see Chart 4). Large catastrophic events are often referred to as “tail events” or “black swans” because they are unexpected from our experience with normal distributions.

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102. Neil F. Johnson et al, “Universal patterns underlying ongoing wars and terrorism,” <http://xxx.lanl.gov/abs/physics/0506213> (accessed November 23, 2013)

103. Yan, Guanhua, Stephan Eidenbenz, Sunil Thulasidasan, Pallab Datta, and Venkatesh Ramaswamy, “Criticality analysis of Internet infrastructure,” *Computer Networks* 54 (201): 1169-1182, [http://www.sis.pitt.edu/~dtipper/3350/April\\_Paper4.pdf](http://www.sis.pitt.edu/~dtipper/3350/April_Paper4.pdf) (accessed February 26, 2011).

104. “Natural Disasters – Forecasting Hurricane Occurrence, Economic and Life Losses,” USGS, [http://coastal.er.usgs.gov/hurricane\\_forecast/hurr\\_losses.html](http://coastal.er.usgs.gov/hurricane_forecast/hurr_losses.html) (accessed June 20, 2012).

105. Javorsek and Schwitz, “Probing Uncertainty,” 7.

Capturing daily granular events worldwide is a challenge requiring automated capture, classification, and aggregation. The Defense Advanced Research Projects Agency (DARPA) has funded a classified effort managed by Lockheed Martin, the Integrated Crisis Early Warning System (ICEWS), which failed to predict the Arab Spring.<sup>106</sup> Until recently, at an unclassified level, the granular event data was not available to integrate into intelligence products to formulate a predictor of change and signal the probability of catastrophic events. Three steps are required for this process. Assuming an event data source: 1) the events must be classified through a taxonomy, 2) an aggregate measure of significance must be applied, and 3) events must be supplemented with intelligence insights. Fortunately the world-wide open data source now exists, the Global Database of Events, Language, and Tone (GDELT).<sup>107</sup> This three-step process has the potential to improve our current intelligence process by signaling the probability of catastrophic events, and justifying intelligence insights with events. Rapidly integrating event data into intelligence analysis provides indicators of possible catastrophic events while supplying context for policymakers. The Presidents Daily Brief, often focusing on events, provides an excellent springboard for this effort.

The three models considered are discussed below.

**SIR Epidemic Model:** The epidemic model, summarized in Figure 17, is a candidate because it is nonlinear and widely used beyond epidemiology to model political or social contagion. In addition, the model has been widely studied and its behavior is well known.

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106. Lockheed Martin website for Integrated Crisis Early Warning System, <http://www.lockheedmartin.com/us/products/W-ICEWS/iSent.html> (accessed February 26, 2014).

107. Global Database of Events, Language, and Tone website, <http://www.gdeltproject.org> (accessed March 3, 2014).

Unfortunately, the model does not serve our purpose because it has only two significant parameters combining to one factor which drives epidemics, the basic reproduction number  $\mathcal{R}_0$ .  $S$  represents individuals susceptible to the disease while  $I$  represents infected individuals. The basic reproduction number is derived from the epidemic differential equations and signals an epidemic

when  $\mathcal{R}_0 > 1$  where  $\mathcal{R}_0 = \frac{\beta N}{\gamma}$  with  $\beta$  the rate of infection for a carrier

$\frac{1}{\gamma}$  – the expected infectious period and  $N$  the total population.

$$\frac{dS}{dt} = -\beta SI \quad \text{Change in number of susceptibles}$$

$$\frac{dI}{dt} = \beta SI - \gamma I \quad \text{Change in number of infectives}$$

Figure 17. Epidemic SIR differential equations<sup>108</sup>

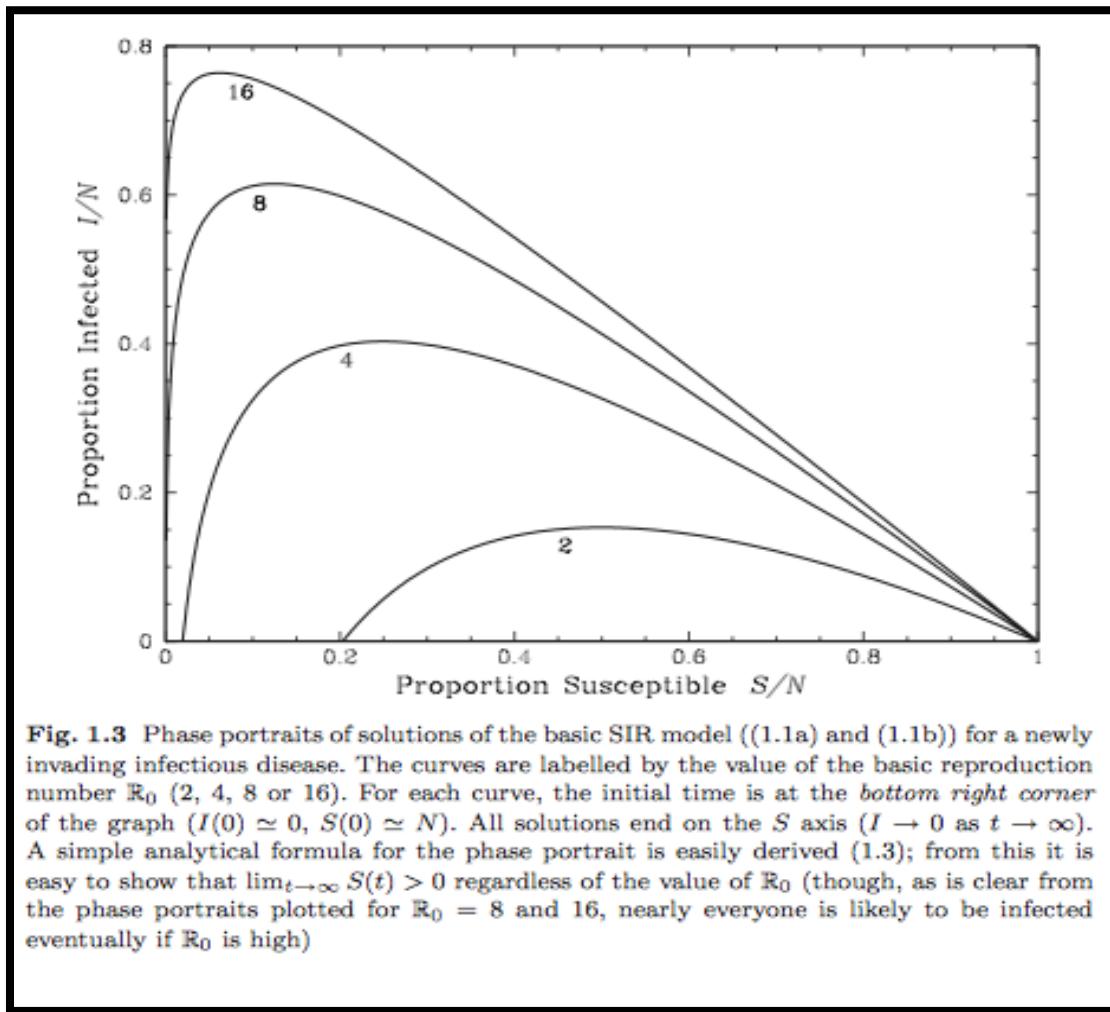
My model requires the magnitude of peak infection and the time to peak infection which is not obtainable from this model. Of greater concern is the absence of any concept of proximity in propagating the infection. In the model, any member of the population is equally susceptible to infection despite physical distance. Also, there is no clear analogy of what percentage “infection” is sufficient for revolution. Immunization

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108. David J.D. Earn, “A Light Introduction to Modeling Recurrent Epidemics,” <http://mysite.science.uottawa.ca/rsmith43/MAT4996/earn.pdf> (accessed November 23, 2013).

of a proportion of the population serves a useful analogy to elites or cops in Epstein's model who act to block revolution (contagion).

The phase diagram (Figure 18) reveals the importance of the Basic Reproductive Number. Larger numbers infect a greater proportion of the population. Unfortunately, the phase diagram does not disclose time to peak infection.



**Fig. 1.3** Phase portraits of solutions of the basic SIR model ((1.1a) and (1.1b)) for a newly invading infectious disease. The curves are labelled by the value of the basic reproduction number  $R_0$  (2, 4, 8 or 16). For each curve, the initial time is at the *bottom right corner* of the graph ( $I(0) \approx 0$ ,  $S(0) \approx N$ ). All solutions end on the  $S$  axis ( $I \rightarrow 0$  as  $t \rightarrow \infty$ ). A simple analytical formula for the phase portrait is easily derived (1.3); from this it is easy to show that  $\lim_{t \rightarrow \infty} S(t) > 0$  regardless of the value of  $R_0$  (though, as is clear from the phase portraits plotted for  $R_0 = 8$  and  $16$ , nearly everyone is likely to be infected eventually if  $R_0$  is high)

Figure 18. SIR phase diagram<sup>109</sup>

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109. Ibid., 9.

**Barabasi Random Networks Model:** Named for its developer Albert-Laszlo Barabasi, this models a network by randomly growing links to the nodes using a rich-get-richer positive feedback algorithm. The probability of each node gaining an additional link is improved by the number of current links. This model simulates the behavior of critical infrastructure. Critical infrastructure demonstrates considerable resiliency; however, if critical nodes are attacked, catastrophic cascading behavior is possible. Unfortunately, the frequency of this “black swan” or tail behavior is far greater than the tail of a normal distribution.

Barabasi, in a series of articles explained the tendency of structure to evolve through internal and external processes toward a critical state.<sup>110</sup> In this case a critical state is characterized by a point where a small perturbation can cause cascading failure. There is no architect or master plan driving this evolution, nor reductive physics explaining the process. What differentiates a critical state is its response to disturbances. Normal state responses to stimulus are confined to a narrow range and are linear with a characteristic response time and scale. A critical state is scale-free, its response to disturbances is non-linear with the possibility of time and scale responses of any size. Most importantly, the response is not deterministic and must be described statistically. A power law is a linear relationship between the log of the frequency of an event and the

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110. Albert-Laszlo Barabasi, “The Architecture of Complexity,” August 2007, *IEEE Control Systems Magazine*, [http://iris.lib.neu.edu/physics\\_fac\\_pubs/106/](http://iris.lib.neu.edu/physics_fac_pubs/106/) (accessed February 23, 2011); Reka Albert, Jeong Hawoong and Albert-Laszlo Barabasi. “Error and attack tolerance of complex networks,” *Nature*, Volume 406, 27 July 2000, [http://www.barabasilab.com/pubs/CCNR-ALB\\_Publications/200007-27\\_Nature-ErrorAttack/200007-27\\_Nature-ErrorAttack.pdf](http://www.barabasilab.com/pubs/CCNR-ALB_Publications/200007-27_Nature-ErrorAttack/200007-27_Nature-ErrorAttack.pdf) (accessed September 05, 2010); and Reka Albert and Albert-Laszlo Barabasi, “Statistical mechanics of complex networks,” *Reviews of Modern Physics*, Volume 74, No. 1, January 2002, [http://www.barabasilab.com/pubs/CCNR-ALB\\_Publications/200201-30\\_RevModernPhys-StatisticalMech.pdf](http://www.barabasilab.com/pubs/CCNR-ALB_Publications/200201-30_RevModernPhys-StatisticalMech/200201-30_RevModernPhys-StatisticalMech.pdf) (accessed September 05, 2010).

log of the scale (size) of the event. This relationship enables an unexpected (versus a normal distribution) number of large-scale events.

**Percolation and Renormalization Model:** Both epidemic and percolation models are well suited to model social or technology adaption through contagion. Percolation describes the diffusion of a liquid through a solid with a critical parameter differentiating a sharp discontinuity between no diffusion and diffusion. Renormalization is the process of simplifying a problem by reducing the dimensionality. It is much easier to solve one and two-dimensional problems than a multi-dimension problem. This model offers several attractive features for modeling complex systems. Firstly, it has been extensively studied and applied to problems in many diverse fields so that the critical parameters are known. Percolation and the renormalization are standard analytic approaches in Statistical Mechanics and earned Kenneth Wilson the 1982 Nobel Prize in Physics “for his theory for critical phenomena in connection with phase transitions.”<sup>111</sup>

Percolation is non-linear with a sharp boundary at the second order phase transition.<sup>112</sup> A second order phase transition is anomalous or emergent behavior where minute changes in local interactions propagate across macro dimensions of the material.

My thesis adapts a percolation model from O’Sullivan and Perry.<sup>113</sup> My model uses a two dimensional lattice (225 x 225 sites) as the substrate for percolation and a characteristic number p. Sites of the lattice (50,625 sites) are originally unoccupied. For each of the sites a number is drawn from a uniform probability distribution (0, 1)

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111. The Official Web Site of the Nobel Prize,  
[http://www.nobelprize.org/nobel\\_prizes/physics/laureates/1982/wilson-bio.html](http://www.nobelprize.org/nobel_prizes/physics/laureates/1982/wilson-bio.html) (accessed February 26, 2014).

112. Kim Christensen, “Percolation Theory” (lecture, MIT, October 2002),  
[http://www.mit.edu/~levitov/8.334/notes/percol\\_notes.pdf](http://www.mit.edu/~levitov/8.334/notes/percol_notes.pdf) (accessed March 8, 2014).

113. David O’Sullivan and George L.W. Perry, *Spatial Simulation: Exploring Pattern and Process* (Chichester, UK: John Wiley & Sons Inc., 2013), 105.

(50,625 draws in all) to determine if the site is occupied. If the draw is above p the site is occupied. Figure 19, generated from my thesis model, demonstrates the effect of varying the characteristic number p. Each of the diagrams is a lattice with a different characteristic number p. For each lattice 50,625 random draws are made and compared to a different value of p. From left to right on the first row p = 0.55, p = 0.45, p = 0.41, and for the second row p = 0.35, p = 0.25.

A cluster is defined as a set of connected occupied sights. Emergent macroscopic behavior (a second order phase transition) occurs when p is equal to a critical number. At this critical point clusters emerge that span the rectangle (extreme events) and the cluster size assumes a power law distribution (scale-free behavior) (see Figure 21). Small movements of the parameter at the critical point generate large non-linear outputs (extreme events). For a two-dimensional lattice the critical number .40 can be theoretically determined. My model confirms this behavior with clusters spanning the lattice occurring at p = .41. My thesis uses this agent-based model as a proxy for demonstrations coalescing into the outbreak of violence across the state.

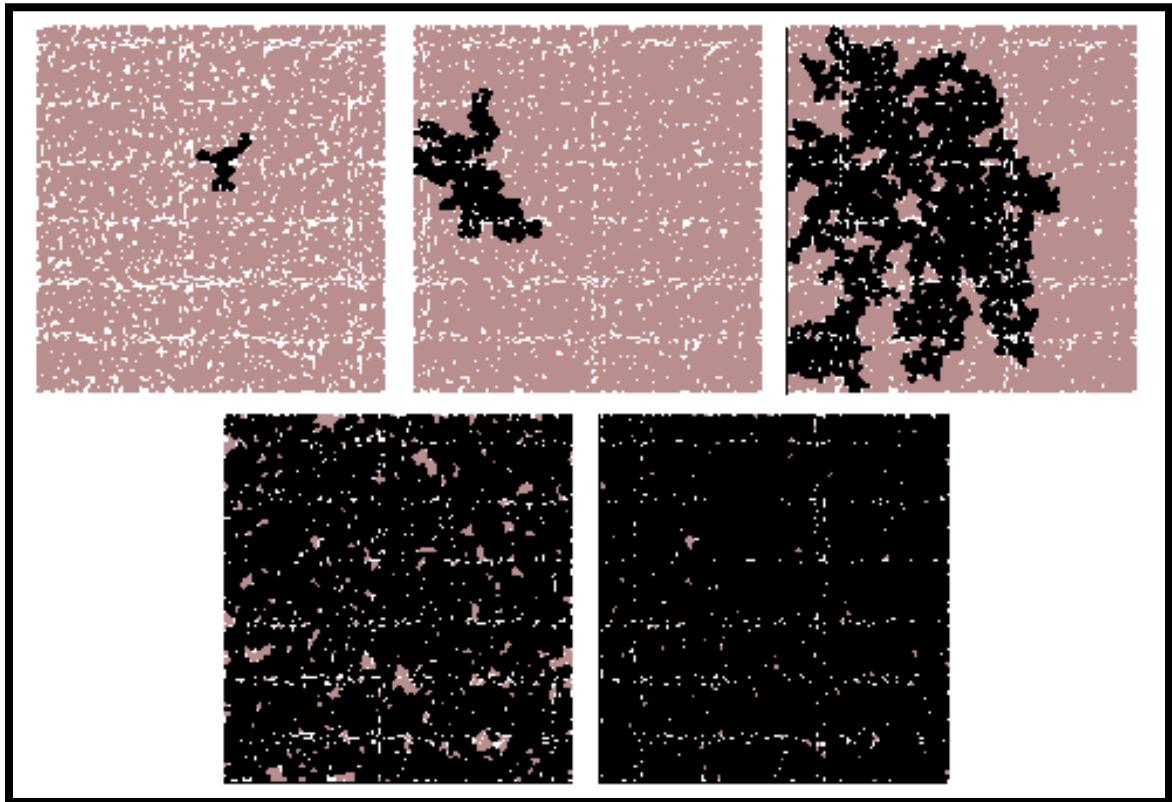


Figure 19. Percolation at varying values of  $p^{114}$

4) *Interpret the agent-based model parameters and justify dynamic responses to change.*

In my thesis model the percolation critical point is modeled as the onset of political instability. A state stability barrier is modeled from structural state parameters in relation to the critical point. The structural state parameters include infant mortality, citizen services, GDP, GDP growth, and military strength. For a stable state the state stability barrier is above the critical point. Initially the model has heterogeneous agents with utility for participating in civil disobedience drawn from a uniform probability distribution (0, 1). Individual agents participate in disobedience only if their utility

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114. Chart generated from my percolation agent-based thesis model.

gained from action exceeds the current state stability barrier. Therefore as long as the state stability barrier remains above the critical point, civil disturbances can be contained by the state.

There is no assurance that an agent's participation in civil disobedience will result in state transition, and individual agents can suffer severe consequences from protesting. Therefore the agent's utility is a combination of utility from potential change balanced against the disutility of the consequences of a failed protest movement. This disutility represents the significant economic and political problem of collective action. The benefits of collective action accrue to all, are dependent on a critical mass of agent participation, but consequences of failed action rebounds only on participants. This structure of rewards creates the free-rider problem: agents not willing to contribute will ultimately benefit without the risk of sanctions from a failed action.

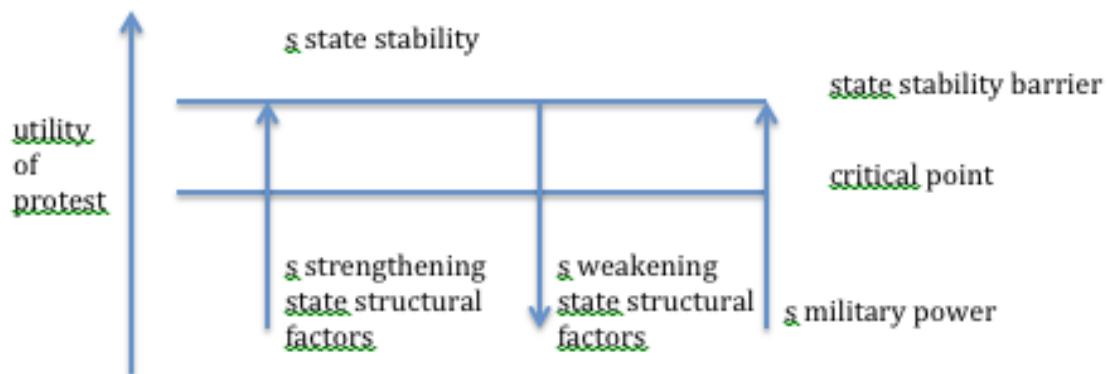
The critical point demarcates a second order phase transition where a critical mass of protestors is reached, precipitating the onset of state instability. At this critical point clusters emerge that span the rectangle (extreme events) (see Figure 19, p = .41) and the cluster size assumes a power law distribution (scale-free behavior) (see Figure 21). This power law behavior may be measurable by intelligence analysts. The use of fine-grained information such as GDELT may permit estimating the size and penetration of civil disturbances. Small movements of the parameter at the critical point generate large non-linear outputs (extreme events).

Figure 20 is a representation of the factor relationships in my agent-based model. The state of the country is represented by the state stability barrier which determines the efficacy of protest and the realization of agent's protest utility. This barrier is

strengthened (raised) by military and police state power and a state delivering citizen services, while it is weakened (lowered) by a fragmented state and neglect of citizen rights and services. In this model, agents interact locally with only local information, and the model is simply that an agent joins the protest only if the agent's utility exceeds the state barrier. An agent with utility below the state stability barrier creates a blockage in the network to collective action. Emerging developments, such as the Arab Spring or cross-border conflict, are modeled by an analogy to increasing entropy (heat/temperature) in a physical system. Increasing entropy causes greater movement of the constituent particles (agents) which raises the utility of protest thereby improving the probability of a phase transition.

The agent-based model is formulated for one state at a time.

The 2 dimensional percolation model has a critical point of .40725379 which can be theoretically derived.



The critical point is a function of the substrate (state). A distribution of agent utilities of protest is set using a uniform probability distribution (0, 1).

The state stability barrier is modeled from structural state factors in relation to the critical point. State structural factors include strength of the military, citizen services, and the economy.

Individual utility of protest increases with poor economic and social factors and decreases with the strength of the military.

The critical point captures the collective action problem and the resultant cascading behavior at the critical point.

Entropy/hear raises the individual levels of agent utility of protest creating increased probability of violence.

Figure 20. Factor relationships of my agent-based model<sup>115</sup>

115. Factor relationships in the author's agent-based model.

The percolation model offers several attractive features for modeling complex non-linear systems. The model is capable of modeling sharp discontinuities such as the Arab Spring and provides statistics adaptable to measuring revolutionary activity. The growth and distribution of cluster size serves as a proxy for the penetration and depth of revolutionary groups and citizen adaption. The exponential distribution of cluster size in the percolation model provides one possible statistical approach to forecasting. The challenge is to relate fine-grained event data from GDELT to proxy individual and group utility for radical change. Figure 21, from the model developed by this thesis, demonstrates the non-linearity of this relationship by the exponential distribution of cluster size.

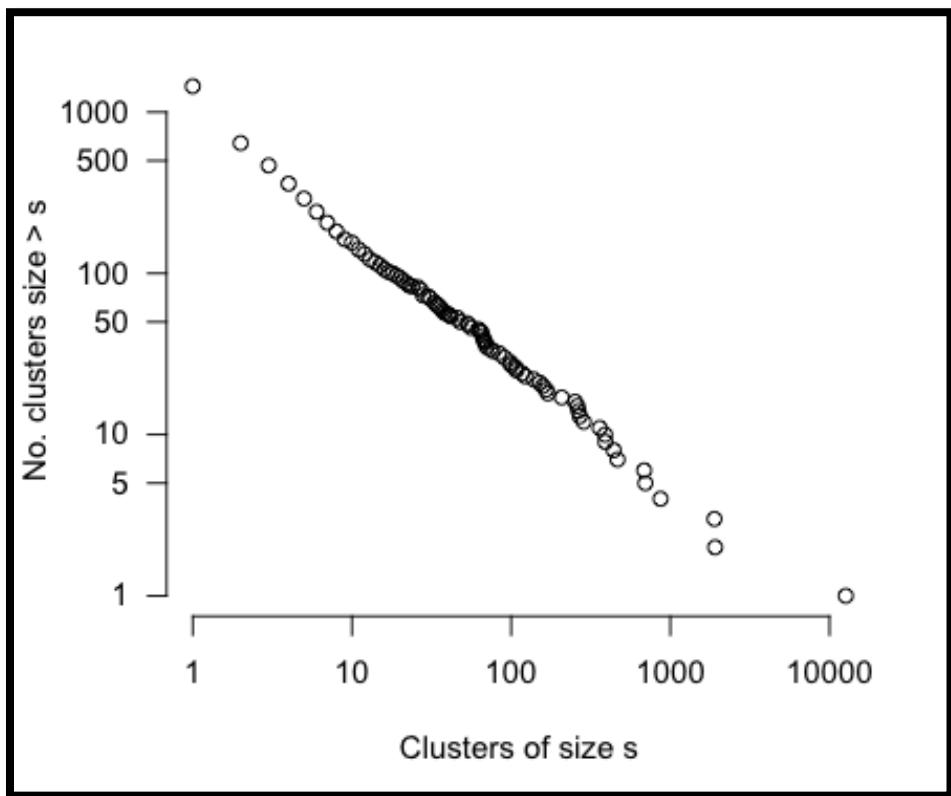


Figure 21. Exponential distribution of cluster size<sup>116</sup>

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116. Exponential distribution of clusters from author's agent-based model.

The sharp discontinuity of the emergence of spanning clusters at the critical parameter  $p$  proxies the mechanism where local disturbances explode into coordinated revolutionary action across the state (the onset of violence). This can be observed from the S curve derived from my model (Figure 22).

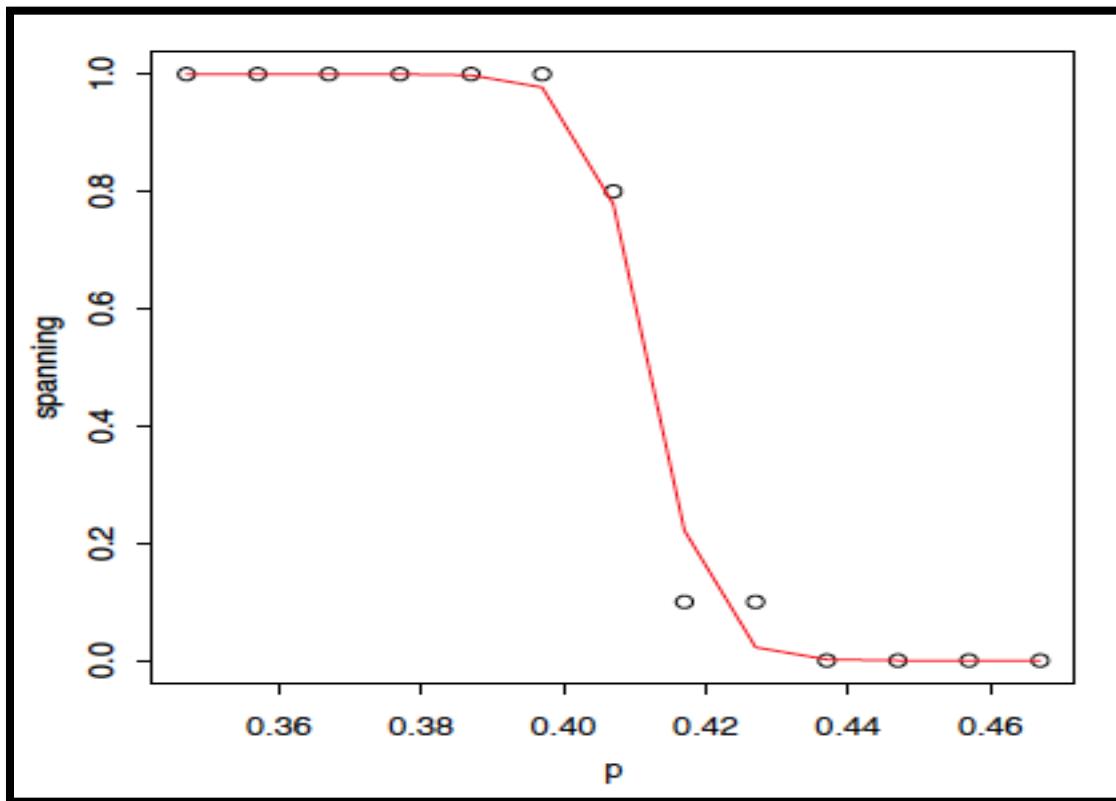


Figure 22. Percent Spanning Clusters at  $p$  (1.0 represents 100%)<sup>117</sup>

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117. Demonstration of sharp discontinuity in protest efficacy from author's agent-based model.

## CHAPTER 7

### Model Results and Alternate Futures

A 2012 publication in *Intelligence and National Security Journal*, “Assessing Uncertainty in Intelligence,” analyzed 379 declassified National Intelligence Estimates (NIEs) written between 1964 and 1994 and found that 53% examine only one possible outcome, 30% examined three or more outcomes, 18% discuss a range of possible outcomes with no sense of probabilities, 4% discuss quantifiable probabilities, and only one discussed more than two possible outcomes and quantified the probabilities.<sup>118</sup> The study found that the analysis had a tendency to conflate the likelihood of an outcome with the confidence in the intelligence. The likelihood expresses the probability of an occurrence, while the confidence qualifies the intelligence by the "scope, quality, and sourcing" supporting the analysis. Both measures must be independently presented.

Intelligence analysts make uncertain judgments on future events. However, the drive toward narrowing uncertainty by focusing on one outcome is inimical to the goals of intelligence. The future is fundamentally uncertain and the uncertainty of intelligence analysis is compounded by adversaries’ uncertain capabilities, denial and deception, and most importantly the often undecipherable nature of human agency. This thesis couples statistical analysis with agent-based modeling to represent complexity, uncertainty, and human agency of the world. This prepares intelligence analysts and policymakers to confront a range of possible futures.

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118. J. A. Friedman, and R. Zeckhauser, “Assessing Uncertainty in Intelligence,” *Intelligence and National Security*, (2012): 27.

The Intelligence Community structured analytic approach of Analysis of Competing Hypotheses has also not been successful in considering multiple outcomes.<sup>119</sup> Unfortunately, the perception by the policymaker to this approach is often that the Intelligence Community did not do its job in providing additional intelligence to reduce uncertainty or the analysis is “hedging bets.”

In order to generate alternate futures explicitly addressing uncertainty, the Collier econometric approach is applied in this thesis. The Collier dataset encompasses all states and contains demographic, social, and political data over the period from 1965 to 2005. Figure 23 displays the Collier predictive variables, the coefficients for these variables, the average values across all states, and the 2014 values for Afghanistan obtained from World Bank forecasts (also Appendix 2.3).<sup>120</sup> Log variables have been transformed to their actual values. The coefficients of these variables for the Collier model are developed in Appendix 2.5.

The model forecasts the onset of violence. Once the econometric model, which uses logistic regression, is developed, the onset of violence can be calculated for individual states or alternate scenarios. Values of predictive variables, for instance 2014 values for Afghanistan, are simply multiplied by the model coefficients in Figure 23 to generate a scenario. My thesis uses this approach in the conclusion to forecast the onset of violence in Iraq, Pakistan, and Afghanistan under alternative scenarios (see Figure 26).

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119. Richards J. Heuer and Randolph H. Pherson, *Structured Analytic Techniques for Intelligence Analysis* (Washington, DC: CQ Press, 2011), 147.

120. The World Bank Global Economic Prospects, <http://info.worldbank.org/governance/wgi/index.aspx#reports> (accessed February 26, 2014).

Predictor Variable - Collier Base	Model coefficient	Average for States	Afghanistan 2014
Log GDP per capita	-0.22	\$1,978	\$416
Growth in GDP per capita	-0.14	1.8 %	3.5 %
GDP from commodity exports	6.99	16 %	33 %
GDP from commodity exports SQ	-14.44	.06	.1089
Years of Peace(months)	-0.06	32	0
Former French Colony in Africa	-1.22	NA	0
Social Fractionalization	2.19	.18	.18
Percent young men in population	12.64	13%	13%
Log of population	.27	4.9 Million	29.8 Million
Percent mountainous terrain	.01	16 %	66 %

Figure 23. Predictive Variables and values for all states and Afghanistan 2014<sup>121</sup>

My thesis first replicated Collier's results, then the thesis examined the Beck approach to rare data, discussed previously, to clearly elicit the predictor values and to correct for bias in the estimate.<sup>122</sup> The resulting rare data model reduced the impact of commodity exports on the forecast of state instability. However, I rejected the rare data results because they did not improve on the statistical fit of the Collier model (see Appendix 2.12). Therefore, my thesis uses the Collier Base Model replicated in Appendix 2.5 for all statistical models.

A point estimate, the mean, is insufficient for intelligence, so uncertainty must be acknowledged. The standard deviation defines a confidence interval using the following approach. The confidence range is the mean plus or minus a number of standard deviations. The confidence that a forecast is within 1, 2 or 3 standard deviations is 68%, 95%, and 99.7% respectively.

My thesis explicitly quantifies uncertainty through three approaches. Confidence intervals of 68% are stated for forecasts, alternate scenarios are developed to capture

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121. Predictive values from author's application of Collier model (Appendix 2.3).

122. Beck, King, and Zeng, "Improving Quantitative Studies".

differing views of internal and external factors driving violence, and I encode nonlinear behavior in the agent-based percolation model. Scenarios are an accepted practice in financial risk management to explore extreme events. All three approaches will be developed in the section succeeding the following narrative on Afghanistan.

### **Afghanistan Narrative**

Any attempt to adopt a general agent-based model to the history, economic and geographic setting of a state requires a study of that state. Unfortunately, Afghanistan's strategic location has subjected it to repeated invasions and conflict with outside forces. In modern times this was named "The Great Game" to describe the strategic rivalry of the British and Russian Empires. The result has been three Anglo-Afghan Wars and invasions by the Soviet Union and the West.

As noted earlier, Afghanistan has evolved into a rentier state – a state dependent on subsidies and funding from other states for essential citizen services and security. Extensive corruption and a thriving cocaine sector contributing about one third of GDP conforms to Acemoglu's portrait of extractive economic and political factors. Hui's self-strengthening reforms leading to internal funding from a strong tax base, selection of ministers on merit, and strong internal security are all absent in Afghanistan.

Additionally, Afghanistan is at an unstable point of the Acemoglu and Robinson Virtuous Circle (Figure 8). Although Afghanistan has staged democratic elections, the economic institutions are extractive and dominated by corruption. Both the large market segment devoted to cocaine and the World Bank Corruption indications substantiate this in Figure 24. Unfortunately, the corruption indicators have significantly deteriorated from 2002 and are rooted in the bottom quintile of countries.

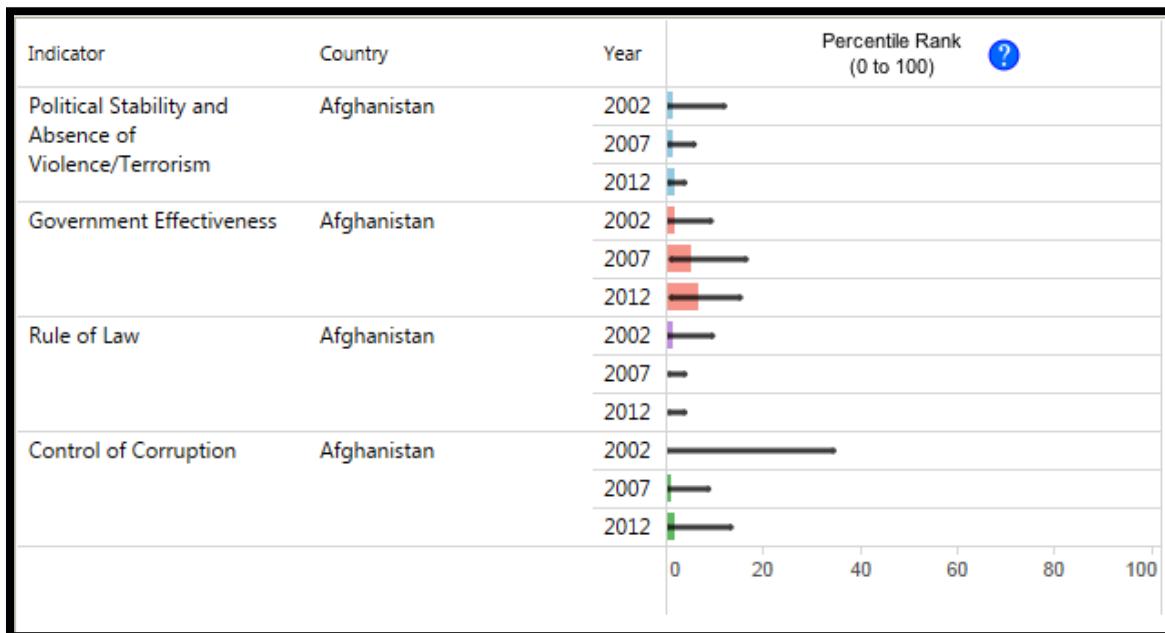


Figure 24. World Bank Governance Indicators<sup>123</sup>

The World Bank reports that 2011 Afghanistan aid was \$15.7 billion, 100% of GDP, and created both benefits and problems (Figure 25). Significant aid has contributed to improved services, infrastructure, and government administration since 2001. However, aid effectiveness has been poor because of corruption, uncoordinated projects, and poor governance. The US Afghan expenditures in 2011 were \$118.6 billion with cumulative spending as high as \$444 billion:

Reflecting steep increases after 2005, civilian aid and spending on the Afghan National Security Forces in 2010/11 (together, “aid”) came to an estimated US\$15.7 billion – about the same as GDP. Although the bulk was security spending, civilian aid is estimated at more than US\$6 billion a year, or nearly 40 percent of GDP. Such aid dependency is almost unique (only a few smaller economies, such as Liberia and West Bank and Gaza, have on occasion received more aid per capita).<sup>124</sup>

123. The World Bank Governance Indicators, <http://info.worldbank.org/governance/wgi/index.aspx#reports> (accessed February 26, 2014).

124. The World Bank, *Afghanistan in Transition: Looking Beyond 2014, Volume 2: Main Report* (Washington D. C.: The World Bank, 2012), appendix.

**Figure O.1 Aid Trends in Afghanistan**

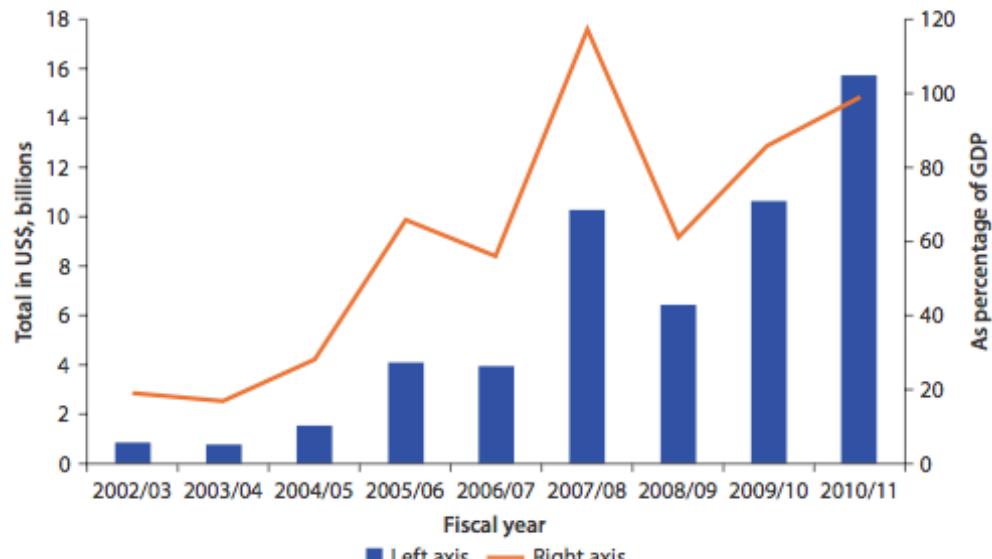


Figure 25. Aid Trends in Afghanistan as percentage of GDP<sup>125</sup>

### *Alternate Futures developed in this thesis*

Figure 26 presents the forecasts developed in my thesis on the expectation of future violence in Afghanistan. The thesis provides a Base Case Forecast, Afghanistan 2014, and two scenarios developed from World Bank projections.<sup>126</sup> The World Bank scenarios are 1) World Bank Base Case and 2) World Bank (WB) Deteriorating Security Case.<sup>127</sup> Forecasts for Pakistan and Iran using 2014 World Bank projections are included for context. The confidence interval expressed as the lower and upper bound is one standard deviation representing a 68% confidence level. These projections are derived in the appendix 2.14 – 2.19.

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<http://siteresources.worldbank.org/AFGHANISTANEXTN/Images/305983-1334954629964/AFTtransition2014Vol2.pdf> (accessed February 26, 2014).

125. The World Bank, *Afghanistan in Transition*, appendix.

126. Ibid.

127. Ibid.

Scenario	Expectation of Violence	sd	lower bound	upper bound
Pakistan 2014	18%	5%	13%	23%
Iran 2014	18%	5%	13%	23%
Afghanistan 2014	41%	12%	29%	53%
World Bank Base	24%	10%	14%	34%
WB Deteriorating Security	48%	16%	32%	64%

Figure 26. Scenario Results<sup>128</sup>

The uncertainty of the forecasts is portrayed by distributions on the forecast in Figure 27. All forecasts were developed before Afghanistan's refusal to renew the security guarantee with the U.S. This action severely deteriorates the future of Afghanistan, because the likely departure of U.S. troops will endanger a high percentage of the world aid to Afghanistan. Because of corruption and instability, most aid is off-budget, meaning it is administered outside of the Afghanistan government. It is unlikely that this aid will be transitioned to the Afghanistan government.

Portraying a forecast as a distribution is an effective way to weight and combine scenarios (see Figure 27). This has the advantage of acknowledging uncertainty on the probability of the onset of violence. The interpretation of the graphs in Figure 27 follows. The x axis represents possible results of the logistic regression which is the binary variable (yes / no) for the probability of the onset of violence (.4 is 40%). The y axis measures the relative probability of the onset of violence. For the case, Afghanistan 2014, the graph indicates that the probability of an onset of violence below 29% is only 16%. Because these are probability distributions the area under each of the curves equals 1 or 100%. Therefore each graph represents the probability (expectation) of the outbreak of violence for varying values of x. Expressed in this manner, a consensus forecast can

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128. Predictive values from author's statistical model (Appendix 2.14 – 2.19).

be developed through a weighted average of the individual scenarios combined into one distribution.

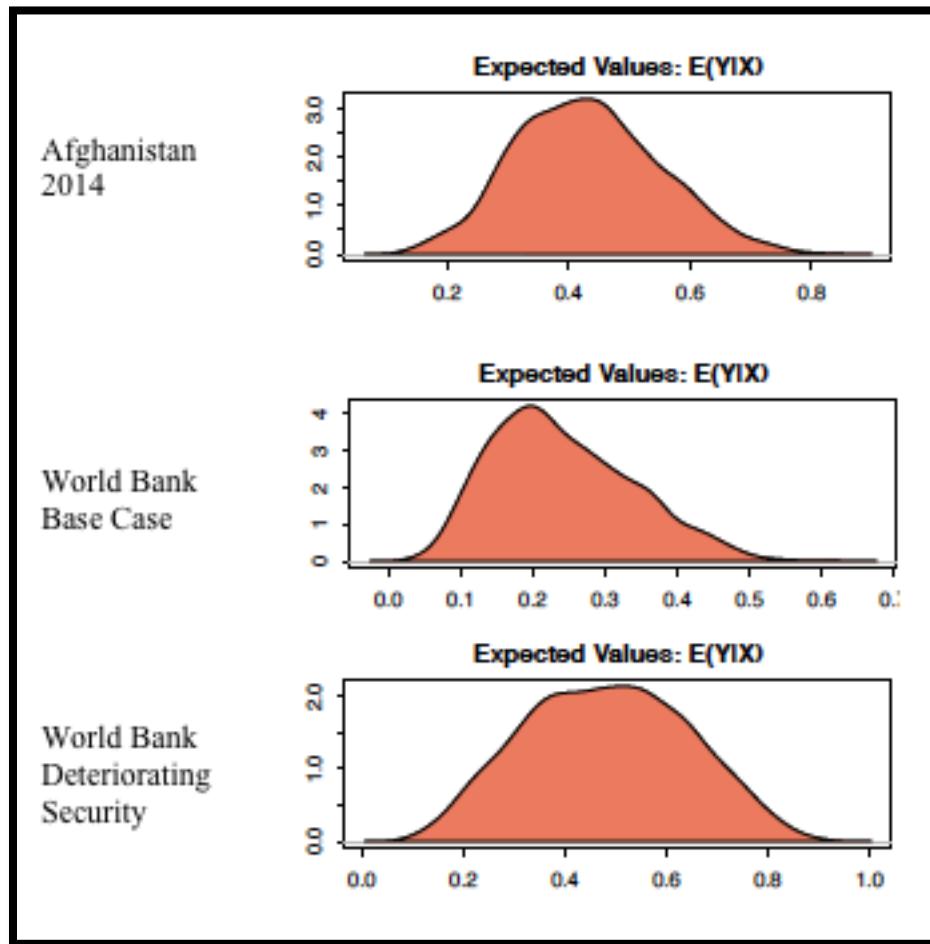


Figure 27. Scenario Probability Distributions<sup>129</sup>

The previously cited World Bank findings on a 15-30 year recovery time for a fragile state, and Lord Hartington's quote on the results of the Second Anglo-Afghan war on page 23 justify this bleak view.<sup>130</sup> I developed forecasts of conflict in Pakistan and

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129. Graphs made by the author of predictive values from the author's statistical model portraying forecasts in Figure 26 (Appendix 2.14 – 2.19).

130. The World Bank, *World Development Report 2011*, 57, and Ewans, *Afghanistan: A Short History*, 97.

Iran because my thesis previously developed the severe consequences of instability in neighboring states.

The scenarios indicate the probability of an event but provide no indicators or warning on the timing of the event. Future versions of the agent-based model will provide indicators and warnings to state instability by calibrating the factors of Figure 20 and identifying fine-grained event data from GDELT to proxy individual and group utility for radical change (Figure 21). This linkage will provide warning on how close the state is to the non-linear and explosive revolutionary activity represented by the s curve generated by the thesis's agent-based modeling (Figure 22). This approach is explored in the conclusions.

## CHAPTER 8

### Conclusions

The models developed in this thesis address critical weaknesses in current Intelligence processes and existing approaches to forecasting failed states. As discussed previously, current intelligence products focus on one possible outcome and fail to quantify uncertainty. My thesis models explicitly acknowledge uncertainty and permit the policymaker to explore options through scenarios and alternate futures. Advantageously, these alternative futures can capture both policy actions and alternative outside events. Intelligence is presented in a manner that permits the policymaker to combine scenarios into a “consensus” view independent of the intelligence analyst.

Unfortunately, current forecasting approaches are based on simple statistical fit on lagging and uncertain indicators, provide no indicators or warning to state failure, are blind to peaceful transitions to democracy, and fail to explore or validate plausible pathways to state failure through qualitative research. Future versions of the agent-based model will provide indicators and warnings to state instability by calibrating the factors of Figure 20 and identifying fine-grained event data from GDELT to proxy individual and group utility for radical change (Figure 21). This linkage will provide warning on how close the state is to the non-linear and explosive revolutionary activity represented by the s curve generated by the thesis’s agent-based modeling (Figure 22). The thesis also advanced approaches to modifying the PITF indicators to signal peaceful transitions to democracy. My models were developed to extensively explored pathways to state failure through mechanisms developed by Acemoglu and Hui and confirmed through

their research. Several of these pathways to failure are quantified through my thesis model in the next section, “Pathways to Failure.”

### ***Pathways to Failure***

Model development is problematic if not informed by qualitative research. The two most quantitative approaches examined in my thesis were constructed on extensive qualitative research. Acemoglu continually applied economic and political causal factors to states and counterfactuals. The Collier model was further investigated through two books encompassing studies by other authors applying and suggesting modifications to the model.<sup>131</sup> In this thesis the absence of specific model factors does not diminish their influence in model formation. These factors served as guideposts to test if “the model got it right”. Four examples drawn from the qualitative factors developed in my thesis.

1. Acemoglu attributed the divergence in income of a factor of ten (Figure 6) to extractive economic and political systems creating a vicious circle of failure. These systems dominate fragile and failed states. Low income and inadequate social services are factors in many of the models of state failure. Collier includes GDP per capita and growth in GDP. States that have experienced conflict are skewed to low per capita income. My analysis conducted in Appendix 2.20 indicates 37% of the states experiencing war are in the lowest quintile of income with 63% in the lowest two quintiles.
2. The previous Afghanistan narrative outlines that all the Acemoglu and Hui state success factors are absent in Afghanistan. Afghanistan has evolved into a rentier

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131. Paul Collier and Nicholas Sambanis, eds. *Understanding Civil War: Evidence and Analysis*, Vol. 1 and 2 (Washington D.C.: World Bank, 2005).

state dominated by corruption and an extractive economy. Presently both essential citizen services and state security are funded by external donors.

3. Collier demonstrated that unfavorable factors combine non-linearly to signal high probability of conflict. Collier examines two hypothetical countries with all predictive factors at the mean excepting the following three factors 1) Former French Colony, 2) Proportion of young men in population, and 3) Mountainous Terrain. The secure country is under the French security guarantee, has one half the average proportion of young men, and no mountainous terrain. The state at-risk is not a former French colony, has double the average proportion of young men and is as mountainous as Nepal. The risks of conflict for the two states are respectively 0.3% and 33%.<sup>132</sup> Collier adds the refinement of additionally considering the effects of population and commodity exports. The secure state has a population of 50 million and no commodity exports. The other state is partitioned into five equal states with 10 million population and commodity exports of 25% GDP. Now the risks of conflict in one of the states are respectively 0.3% and 99.8%.<sup>133</sup>
4. The policies of the twentieth century to create, protect, and reward weak states and the fragmentation of territories to “solve” conflict has resulted in a chronic situation with 28% of the states failing (Figure 4).<sup>134</sup> The recent partition of Sudan is only the most recent example.

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132. Collier, “Beyond greed and grievance,” 25.

133. Ibid.

134. Rotberg, *When States Fail*, 2.

My thesis hypothesis was proved through the combination of statistical analysis and agent-based modeling to provide indicators and warnings on the onset of violence for fragile states. It is fortuitous that I accomplished this with models applicable to all fragile states. Therefore, the general model can then be adapted to a specific state. It is not feasible to construct individual models for each fragile state. Beside the effort and complexity of model building for each state, sufficient historical data would not be available to validate the model. My approach was adapted to Afghanistan to generate alternate futures through scenarios followed by indicators and warnings from the agent-based percolation model.

Modeling for this thesis required a two-stage approach to develop alternative futures on fragile states. First, the Collier econometric model on state failure was adapted to forecast the probability of political violence across all states. I examined and rejected methods to handle missing and rare data and improved the approach through exploring scenarios and uncertainty. No indicators and warning can be extracted from this model, only the probability of violence within a five year period and alternate scenarios. My approach of portraying a forecast as a distribution is an effective way to weight and combine scenarios. This has the advantage of acknowledging the uncertainty on individual scenarios with the possibility of a combined forecast encompassing a weighted average of all scenarios presented as a probability distribution.

Second, my thesis developed an agent-based percolation model to capture the dynamic factors signaling the approach of violence (indicators and warnings) and adapted to specific state factors. Currently the agent-based model only captures the complexity of the transition to political violence through the cascading adaption of protest at the critical

point. However, I advanced suggestions for broadening the approach by estimating protest strength and penetration through GDEL T event data, and modifications of the model to represent other actors and the environment. These improvements truly address indicators and warnings through leading indicators. The significant remaining challenge is to relate my approach to proxy measures consistent with theory and empirical measures derived from history.

My model was applied to Afghanistan explicitly acknowledging uncertainty, alternate futures, and the often observed non-linear and rapid transition to conflict. My approach sharply contrasts with the current statistical approaches which can only identify correlates from history, do not address uncertainty, ignore extreme behavior, cannot incorporate external events, and do not support scenario development.

Therefore, beyond satisfying the thesis hypothesis, I have provided a methodology and data sources to begin to go beyond quantifying the probability of the scenarios by estimating indicators and warnings on how close a fragile state is to tipping into violence – the all important when.

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