A COMPUTATIONAL THEORY OF ENDOGENOUS NORM EMERGENCE:
THE NORMSIM AGENT-BASED MODEL IN MASON

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy at George Mason University

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DEDICATION

This is dedicated to Laura, the person I could never live without, and to my parents Daniel and Lisa whose love and support have carried me through to this day.

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ABSTRACT

A COMPUTATIONAL THEORY OF ENDOGENOUS NORM EMERGENCE: THE
NORMSIM AGENT-BASED MODEL IN MASON

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The current study presents the NormSim Agent-Based Model in MASON. NormSim
conducts a computational analysis of the International Relations theory of constructivism.
NormSim explores the metastable dynamics of norms through the interactions of
heterogeneous agents embedded within a complex social system. The goal is to explain
how the social complexity of international relations generates metastability. The use of
ABM and the MASON simulation toolkit make it possible to explore this process from a
formal experimental perspective. This is advantageous for constructivist research that
typically must rely on qualitative analysis alone to justify complex theoretical
assumptions. NormSim demonstrates the use of ABM to test the logical consistency of
constructivist claims. It also extends constructivist logic to better understand why
international norms lead to complex conformity patterns and long run systemic change.
NormSim provides a general computational theory to explain this phenomenon.

1. INTRODUCTION

1.1 A Formal Analysis of Change in the International System

Complex social systems pose a formidable challenge to scientific inquiry. On the one hand, it is necessary to distill such systems to their essential characteristics so as to understand how they operate without undue complication. On the other hand, one must be careful not to oversimplify the critical elements that make such systems complex; where one draws the line can have a significant impact on explanatory power.[1] In the field of International Relations (IR), I believe this line is often draw much too conservatively. Most IR theories err on the side of simplicity. This is often done to avoid the methodological limitations of qualitative analysis or to make theoretical assumptions analytically tractable—or both. Simple, testable hypotheses enable the development of convincing theories but they also strip the international system of much of the complexity that makes interstate relations interesting and dynamic. The root of this problem seems to stem from the pursuit of law-like regularities. Those who insist on this approach also

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[1] John H. Miller and Scott E. Page, *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*, illustrated edition. (Princeton University Press, 2007), chap. 1.

claim a monopoly on scientific explanation.[2] Thus, the standard for robust theory in the

field of IR stands in stark contrast to the complexity of the international system itself. The

following study shows why this is both unnecessarily limiting and potentially misleading.

One of the primary objectives of IR theory is to explain—or at least better understand—

the behavior of states.[3] The complexity of the international system makes this a difficult

task.[4] It forces one to simplify the behavioral problem. This can be done in a number of

ways. The classic approach to simplification is to overemphasize the rigidity or enduring

nature of state behavior. Traditional IR theories built upon a rational materialist

foundation (e.g., neorealism and neoliberalism) take this route frequently. These

frameworks identify the mechanisms responsible for behavioral regularities but not

change.[5] This is unfortunate because change is an enduring feature of international

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[2] The standard for scientific explanation in the field of International Relations is described in King, Gary, Robert Owen Keohane, and Sidney Verba, *Designing social inquiry: scientific inference in qualitative research* (Princeton University Press, 1994).

[3] Of course, the state-based perspective has its limitations. I examine a few of the most important of these within this study. However, the choice of states as the primary international actor has a long historical pedigree in the field of International Relations. See David A. Lake, "The State and International Relations," *SSRN eLibrary* (June 28, 2007), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1004423.

[4] This problem is not new to the field of International Relations. Although globalization and political integration may amplify this problem, the field of IR has long found it difficult to explain state behavior in a way that can account for the inherent complexity of the international system. For a review of the classic complexity problem, see J. David Singer, "The Level-of-Analysis Problem in International Relations," *World Politics* 14, no. 1 (October 1, 1961): 77-92.

[5] I describe this problem in greater detail below but this criticism largely centers upon the classic constructivist critique of rational materialism. For a review of this criticism, see

politics.[6] The state itself is a product of change.[7] It has evolved from the embodiment of the sovereign to an abstract sovereign agent in its own right. In some areas, the European Union (EU) as an example, it is possibly evolving into a supranational entity. These changes clearly have implications for state behavior. At the same time, changes in state behavior also shape the future possibilities of the international system.[8] The problem with the field of IR is that it fails to provide an appropriate method to understand and explain this complex feedback loop. I propose the NormSim computational framework as a potential solution to this problem.

This study addresses the following questions:

1. *How do social norms emerge and evolve to generate order in a complex system?*

2. *Can we use constructivist logic to devise an endogenous explanation for norm change?*

3. *Can we generate the metastable dynamics of norms and order in the international system using an Agent-Based Model?*

Alexander Wendt, "Constructing International Politics," *International Security* 20, no. 1 (July 1, 1995): 71-81.

[6] For a detailed review of this discussion and an initial attempt to develop a theoretical understanding of this problem, see James N. Rosenau, *Turbulence in world politics: a theory of change and continuity* (Princeton University Press, 1990).

[7] Stephen D. Krasner, "Sovereignty," *Foreign Policy*, no. 122 (January 1, 2001): 20-29.

[8] The basic social constructivist critique of rational materialism is found in Alexander E. Wendt, "The Agent-Structure Problem in International Relations Theory," *International Organization* 41, no. 3 (July 1, 1987): 335-370.

Of course, no framework can explain every instance of—or motivation behind—state behavior. This study is not immune to the problems of simplifying reality. However, NormSim takes a fundamentally different approach to simplification. The objective of NormSim is to capture just enough complexity to explain change without losing analytical tractability. Three elements are critical to success. First, I use existing theory as a guide to model development. I show how traditional IR theory has led to a static understanding of the international system and I explain how current IR theory has attempted to re-conceptualize this system from a dynamic perspective. I focus specifically on social constructivist efforts to overcome the limitations of rational materialism—neorealism and neoliberalism.[9] I also highlight the difficulties constructivists have had in developing a dynamic and falsifiable framework of state behavior. Second, I use insights from complexity theory to reframe this basic constructivist foundation. I explain how constructivist logic can generate dynamic behavioral orders within a socially complex system. I identify crucial mechanisms of social complexity responsible for long run behavioral evolution. Finally, I use Agent-Based Modeling (ABM)[10] to test this proposed reframing of constructivism. The ABM approach allows for a formal analysis of NormSim's complex generative explanation for the metastability of the international system.

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[9] Ibid.

[10] For an introduction to this approach, see Gilbert, Nigel *Agent-based models* (SAGE, 2008).

The purpose of this chapter is to demarcate the bounds of the current study. Ultimately, this study is about change but I need to explain why change is such a difficult concept for existing IR theory. I also describe how this study plans to overcome these limitations. I provide an initial outline of this argument below and I expand upon this idea in the second chapter. Next, I highlight the major components of the proposed NormSim framework. I explain how I operationalize key aspects of social complexity to replicate the metastable order of the international system. I argue that current IR frameworks fail to account for this dynamic because they largely oversimplify the complex interface between agency and structure. This is the fundamental weakness of rational materialism but I show how constructivism struggles with this problem as well. I also explain why it is necessary to recast constructivist claims to understand how the international system functions as a complex social system and what impact this has for state behavior and international order. A more thorough discussion of this topic is found in the third chapter. Finally, I describe how I validate the theoretical assumptions proposed within NormSim. I argue that ABM experimentation is necessary because the NormSim framework is built upon a complex emergent foundation. I describe the MASON[11] NormSim model used to validate these claims in the fourth chapter and I present and discuss the experimental results in the fifth chapter.

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[11] For an introduction to the MASON simulation environment, see Luke, Sean et al., "MASON: A Multi-Agent Simulation Environment," *Simulation: Transactions of the Society for Modeling and Simulation International* 81, no. 7 (July 1, 2005): 517 -527.

1.2 The Evolving International System

The international system is an evolving system. Much of the order that emerges within this system closely resembles the metastable macro patterns of a complex adaptive system.[12] Periods of behavioral equilibria are often punctuated by temporary adjustments that cause the system to shift to new equilibria. Despite this metastability, traditional IR theorists almost always explain state behavior from the perspective of a single overarching equilibrium order. This is because traditional theory often abstracts away the behavioral detail responsible for metastability. All state behaviors are expected to fall into the same utility maximization category. The problem with this highly abstract utility-maximization approach is that it makes it impossible to understand how or why state behaviors evolve over time. Traditional theorists argue that such behavioral detail is inconsequential because the system tends to cancel out minor deviations from the expected order.[13] However, in a complex social system such as the international system, minor deviations can have major consequences.[14] The behavioral adaptations of the states of the European Union (EU) are an excellent case in point. Even if one buys the utility-maximization equilibrium argument, one finds a disjointed overlap between current EU member state behavior and the balance of power behaviors that epitomized Europe prior

[12] William R. Thompson, *Evolutionary Interpretations of World Politics* (Psychology Press, 2001).

[13] Kenneth N. Waltz, *Theory of International Politics*, 1st ed. (Waveland Pr Inc, 2010), chap. 6.

[14] Rosenau, *Turbulence in World Politics*, chap. 3.

to the establishment of the European Coal and Steel Community. Furthermore, not only have the EU states overcome mutual distrust, they have also developed a common European identity that includes a growing package of behavioral norms.[15] This study claims that it is possible to understand how such change occurs using a dynamic framework of the international system.

The goal of NormSim is to formally analyze the metastable character of state behavior and international order. I argue that the root of this metastability lies in the social adaptability of states. Social adaptation introduces a new layer of complexity into the behavioral picture. Such complexity is something most IR frameworks try to avoid. This is because adaptive behavior is much more difficult to explain than static utility maximization. It requires a framework that can simultaneously account for the opposing forces of behavioral consistency and change. The field of IR has focused almost exclusively on the consistency dimension of state behavior at the expense of understanding change. Such an approach enables a positivist confirmation of behavioral assumptions.[16] Consistency frameworks are advantageous in that they postulate only one predicted behavior to confirm or disconfirm. Explaining change is much harder. It requires one to account for multiple behaviors that evolve over time. To do this, one must

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[15] Thomas Risse, *A Community of Europeans?: Transnational Identities and Public Spheres* (Cornell University Press, 2010), chap. 1.

[16] For a discussion on the classic positivist approach to social science research, see Gary King, Robert Owen Keohane, and Sidney Verba, *Designing social inquiry: scientific inference in qualitative research* (Princeton University Press, 1994).

carefully identify shifting pockets of order to confirm dynamic behavioral assumptions. This opens dynamic frameworks up to positivist criticism. Dynamic frameworks are often faulted for their logical inconsistencies and subjective approach to validation. Although such frameworks highlight an important dimension of state behavior, their lack of a formal means to test complex claims makes it difficult to address this criticism. In the remaining chapters of this study, I explain how NormSim can be used to experimentally validate such dynamic behavioral assumptions.

NormSim addresses one of the most important barriers to the development of IR theory: the need to formalize static theoretical assumptions for validation purposes. Such a requirement has encouraged the growth of overly rigid frameworks that cannot account for the emergent dynamics of the international system. This problem began with the early rational materialist theory of neorealism. Neorealism attempted to reduce a complex social system into a set of highly deterministic rules of behavior.[17] The goal was to minimize the theoretical ambiguity of prior reductionist theories in an effort to devise testable behavioral assumptions. To do this, neorealists stripped the state of all the social factors responsible for behavioral diversity and long run systemic change. The result was a security driven automaton whose behavior was contingent entirely upon the distribution of material capabilities throughout the system. Validation became a simple accounting problem—adding up the material resources of states. From this static standpoint, neorealists could only explain changes in state behavior if the distribution of material

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[17] Waltz, *Theory of International Politics*.

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power changed. The major disadvantage to this approach is that the international system evolved in ways neorealists could not anticipate. Neorealists had overfit their explanation for international order to a single balance of power equilibrium. This left alternative behavioral equilibria entirely outside the scope of neorealist explanation.

Neoliberals were the first to highlight the static drawback of neorealism. To do this, neoliberals focused on identifying the countless instances of cooperative order that did not fit the neorealist balance of power understanding of the world.[18] Neoliberalism was able to show that it was possible to rework the basic neorealist premise to explain how cooperative orders emerged within the disorder of the anarchic international system. Rather than assuming a survival of the fittest mentality, neoliberals argued that states could use institutional mechanisms to secure absolute gains outside the security realm. This enabled neoliberalism to account for the growing number of international regimes that appeared to defy the neorealist self-help explanation for order. Although the work of neoliberalism helped to shed light on the limitations of static neorealist theory, neoliberalism had not entirely overcome this static problem itself. Neoliberalism simply began from a different starting point than neorealism to achieve outcome dynamism— explaining the existence of alternative orders. However, their adoption of the neorealist fixed-interest approach to state agency could not explain the process dynamism inherent in socio-structural change—the social factors responsible for changes in state interests

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[18] Robert O. Keohane and Joseph S. Nye, *Power and Interdependence*, 2nd ed. (Pearson Scott Foresman, 1989).

over time. This meant that neoliberalism could only account for changes in state behavior tied to institutional restraint.

The problem with the traditional theories of neorealism and neoliberalism is that they both overemphasized the importance of behavioral consistency. Their goal was to delineate the set of fixed preferences that could lead to a specific recurring pattern of state behavior. This led to a critical misunderstanding of the basis of behavioral change. The methodological individualist position of rational materialism forced one to view behavioral change as an exogenous process. In other words, change was believed to be the product of factors external to the state, such as changes in the distribution of material power or the establishment of international institutions. State agency was predetermined from the outset, so the only explanation for change had to come from materially defined structural forces. Consequently, the rational materialist framework worked so long as it was possible to clearly identify the exogenous material change that preceded changes in state behavior. This was not always possible. As constructivism was able to demonstrate, behavioral change can—and does—occur without material change.[19]

Static rational materialist explanations for state behavior have come under severe criticism for their inability to address behavioral change absent material change. The problem with the fixed-interest approach of rationalism materialism is that it fails to

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[19] Emanuel Adler, "Seizing the Middle Ground: Constructivism in World Politics," *European Journal of International Relations* 3, no. 3 (1997): 319 -363.

account for the social aspect of state behavior. Recent constructivist research has shown why this severely limits our understanding of the dynamism inherent within the international system.[20] Constructivists have highlighted the fact that material change is not the only path to behavioral dynamism.[21] To account for endogenous change, constructivists have focused on the complex intersubjective connection between agency and social structure. Rather than assuming fixed interests, constructivists have examined the various ways in which interests emerge through social interaction. This has enabled constructivists to explain how non-material factors, such as norms and identities, shape state interests. Constructivists argue that it is this mutual constitution of reality that sustains international order and that identifying change in this dimension is crucial to our understanding of how the international system evolves over time. The problem with this approach is that it leads to a number of obvious validation concerns. This is because constructivists often relax the rational materialist premise of behavioral consistency without providing their own falsifiable assumptions to test. Thus, constructivism provides a potential dynamic framework for overcoming the limitations of static theory but it lacks an appropriate method for validating its complex theoretical claims. I argue that NormSim offers a solution to both the rationalist and constructivist problems.

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[20] Finnemore, Martha and Kathryn Sikkink, "International Norm Dynamics and Political Change," *International Organization* 52, no. 4 (October 1, 1998).
[21] Wendt, Alexander E. "Anarchy is what States Make of it: The Social Construction of Power Politics," *International Organization* 46, no. 2 (April 1, 1992): 391-425.

1.3 The NormSim Framework

As I have argued above, the international system is a complex social system. It does not lend itself to simplistic explanation. Nevertheless, it is necessary to simplify this system to understand it. The goal is to avoid washing away the complexity critical to one's research phenomenon in the process. Most IR theories focus on a single dimension of international order to achieve this goal. For example, neorealist and neoliberal studies begin with either competitive or cooperative order and then attempt to explain how rational utility-maximization generates such order. On the other hand, constructivist studies often begin with a target normative order and then attempt to show how states come to conform to this order over time. This linear approach to explaining emergent order tends to overlook the behavioral and social complexity of the international system. It also leads to static behavioral assumptions and/or a one-way understanding of change. To understand how international order evolves and why it is inherently metastable, the field of IR needs a better way to demonstrate and validate its theoretical claims. I propose the NormSim framework and computational model to accomplish this goal.

NormSim provides a bottom-up generative explanation for order in the international system. It combines the social dynamism of constructivism with insights from complexity theory to explain how normative orders emerge and evolve over time. NormSim formally demonstrates how the relatively simple constructivist logic of appropriateness can generate metastable emergent orders in a socially complex environment. The addition of

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social complexity is important because the constructivist framework does not draw an explicit connection between agency and structure. Constructivism highlights the importance of intersubjectivity for state behavior but it fails to formally define the mechanisms states use to connect with the social structure of the international system. The interface between agency and structure remains highly ambiguous and simplistic in standard constructivist research. I argue that we need a better way to investigate the role social complexity plays in shaping this interface. This can help us to better understand why normative orders are complex and dynamic. NormSim shows that a simplistic "global" understanding of intersubjectivity results in a single-shot explanation of emergent order.

NormSim identifies two important features of social complexity necessary to generate metastability. First, NormSim uses social circumscription to replicate the effects of local conformity and global diversity. This effect is impossible to generate from simplistic global interaction alone. NormSim shows that a socially circumscribed intersubjective context can generate much greater macro-level heterogeneity than the standard global intersubjective context of constructivism. Social circumscription allows for the parallel emergence of different stable sub-systemic normative orders. Second, NormSim uses this global diversity to catalyze metastability. Intersubjective diversity provides an important foundation to systemic change. It allows for the persistence and diffusion of conflicting interpretations of order. Such instability punctuates the order between socially circumscribed regions of the intersubjective context causing the system to evolve over

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time. The combination of constructivist logic and social circumscription then reestablishes a new complex systemic order. NormSim demonstrates how this complex emergent dynamic leads to systemic metastability.

NormSim formally demonstrates how "noise" impacts systemic order. Noise is crucial to formal analysis because it determines the extent to which a theoretical framework can account for "unexpected" deviations from the current order. Noise also explains why social systems retain their macro-level diversity rather than evolving towards global homogeneity. Frameworks that fail to capture the effects of noise also fail to understand how order evolves over time. Yet, noise is a concept that rational materialist frameworks ignore almost entirely. Strict adherence to utility maximization eliminates noise and this then highly restricts the possibility for future systemic change. Constructivism, on the other hand, accepts the fact that social systems are "noisy." Constructivists believe noise is the major reason why it is impossible for states to act solely upon fixed interests. Constructivists use noise to criticize rational materialism and they often point to noise to justify violations to the current (or emerging) normative order. However, the constructivist understanding of noise is largely underspecified. Constructivists do not formalize the "noisy" relationship between agency and structure. This makes it difficult and sometimes impossible to validate this effect. NormSim provides a platform for a formal analysis of noise and for understanding the consequences social noise has on systemic order.

1.4 Testing the Proposed Framework

NormSim models the international system as a metastable system. This approach permits

a more nuanced understanding of international order. Yet, it also has the potential to

result in a methodological quagmire. To avoid this problem, most researchers target static

orders. This is particularly useful for validating theoretical assumptions. Researchers can

devise a set of static decision-making mechanism to justify a static macro behavioral

pattern. Validation centers upon the degree to which assumptions match this intended

target. Actions that violate the expected macro pattern are highlighted as evidence

falsifying the framework. This is a reasonable approach to validation for short-term

orders but it leads to the invalidation of frameworks that fail to fit this static template.

Dynamic behavioral frameworks face this problem frequently. Neither their behavioral

assumptions nor their expected behavioral patterns are static. It is much more difficult to

determine which behaviors violate these basic assumptions, given that such frameworks

are aiming to replicate a moving target. The MASON NormSim model demonstrates how

to validate these frameworks using metastability as a validation target.

Dynamic behavioral frameworks require dynamic validation techniques. The popular

constructivist approach to dynamic validation is process tracing.[22] Process tracing is an

informal qualitative approach to validation. It involves identifying an established

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[22] Audie Klotz and Cecelia Lynch, *Strategies for research in constructivist international relations* (M.E. Sharpe, 2007).

behavior (or normative order responsible for this behavior) and tracing the replacement of this behavior with a new behavior over time. Much of this approach is open to the theoretical bias of the researcher. First, the researcher must ascertain the social acceptance of the "entrenched" behavior at time zero. Behaviors are rarely fully entrenched and, thus, any historical review is likely to produce conflicting degrees of entrenchment. Second, the researcher must determine the level of entrenchment of the new behavior at a future point in time. This step is even more difficult and potentially contentious because it is highly unlikely that the previously "entrenched" behavior disappears entirely. Critics of dynamic frameworks are quick to highlight such "violations" as evidence against the study in question. This criticism often overlooks the fact that complex social systems always contain multiple competing normative orders. Finally, those who use process tracing must also justify that their proposed "cause" of behavioral change is in fact due to the emergence of the new normative order and not the myriad of external factors that could potentially account for this change. This is an extremely difficult task to accomplish without a formal means to tests complex theoretical claims. Thus, the process tracing approach remains open to the classic criticism that "correlation does not equal causation."

Of course, the purpose of research is not to avoid criticism. The problem with process tracing is that it draws criticism upon dynamic frameworks for the wrong reasons. It is too subjective to placate those who prefer a more positivist approach. Process tracing makes dynamic theoretical assumptions difficult to falsify. However, I argue that

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dynamic frameworks are in fact falsifiable. It is possible to test the theoretical

consistency of dynamic frameworks using a more formal validation technique. The

following study uses agent-based modeling (ABM) to conduct a formal analysis of the

tenets of the proposed NormSim framework. The goal of the MASON NormSim model is

to see if the proposed assumptions generate the expected changes in order from the

"bottom-up."[23] The ABM approach can be used to confirm the logical consistency of the

NormSim framework. In other words, ABM simulation serves as the positivist check on

theory that critics of dynamic frameworks describe as so important for falsification.

Passing this hurdle, it should then be possible to conduct the classic process tracing

analysis with greater confidence in the validity of the proposed behavioral assumptions.

This is why the following study places such a heavy emphasis on ABM experimentation.

ABM is a computer simulation solution to validation.[24] It is particularly well suited for

the analysis of emergent or evolving phenomenon. The ABM arena provides a form of

objective experimentation not possible with process tracing. Such an approach is crucial

for any study attempting to capture greater complexity and dynamism than standard

qualitative methods allow. The major strength of ABM is that it requires a strict

operationalization of behavioral assumptions. Researchers need to specify a set of micro

rules for agent interaction before they can use the simulation environment to generate the

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[23] Joshua M. Epstein, Robert Axtell, and 2050 Project, *Growing artificial societies: social science from the bottom up* (Brookings Institution Press, 1996), chap. 1.

[24] G. Nigel Gilbert, *Agent-based models* (SAGE, 2008).

various macro patterns expected. This initial operationalization step is often a missing

component of most constructivist frameworks and it is something that process tracing

cannot overcome. Process tracing works with or without a clear specification of the

connection between behavioral mechanisms and the dynamic behavioral pattern one

seeks to replicate. On the other hand, ABMs require clearly specified behavioral

assumptions simply to execute the model itself. ABMs also provide a clear approach to

validating the connection between micro mechanisms and resulting macro patterns.

Simply put, the expected macro pattern either emerges throughout the simulation or it

does not. In other words, either one's behavioral assumptions generate the expected result

or they do not.

The primary goal of this study is to demonstrate the analytical advantage of using ABM

as a tool for theory testing. The strength of this approach lies in its ability to investigate

complex emergent dynamics. Such dynamics abound in the international system.

Throughout this study, I reflect on one of these empirical examples to highlight the

critical difference between the current IR understanding of order and the NormSim

framework. I argue that the evolutionary pattern of international security behaviors within

the European Union follows many of the same complex dynamics produced in NormSim.

I use the internal division within the EU at the time of the Iraq War as a dynamic

validation target. I have chosen this target for a number of reasons. First, as I explain in

the second chapter, this particular behavioral pattern is one that largely falls outside the

scope of traditional IR theory. Second, I also show that the standard constructivist

explanation for order makes it difficult to account for this division. On the surface, the Iraq War case appears to invalidate the basic norm conformity expectation. EU member states were openly acting against the will of the community. However, as I show in the final chapter of this study, it is possible to explain this behavior using the NormSim understanding of complex dynamic order. I show that the local-conformity/global-diversity pattern in place at the time of the Iraq War was just a temporary metastable pattern in an evolving complex social system. The advantage of NormSim is that it can hit this complex dynamic target and it can also explain how the system is likely to evolve moving forward. In this way, NormSim overcomes the static and single-shot understanding of order that limits current IR theory.

1.5 Conclusion

One of the major obstacles to the development of IR theory is the continual evolution of the international system. This evolution occurs in many different forms. For example, the cast of major political actors continues to expand beyond the state to include a wide range of inter- and non-governmental actors. States themselves have also evolved, some in response to the pressures of non-state counterparts others in response to changing political circumstances. This systemic dynamism is impossible to capture in parsimonious theory. However, without it, we often fail to understand the evolution of the international system. Thus, we seem to stand at a theoretical crossroads in that either we must sacrifice our ability to understand change for the sake of analytical clarity or we can

accommodate change and sacrifice our ability to understand our theories. I argue that it is possible to have both clarity and change at the same time. This will require a shift in both our theoretical and methodological approach. The theoretical shift itself has already begun. Social constructivism has already emerged as one of the leaders of understanding change. What is missing from constructivism is a way to validate complex theoretical assumptions. The NormSim model shows how to make this happen.

2. LITERATURE REVIEW

2.1 Dynamic Order: Targeting the Mechanisms of Change

The current study uses Agent-Based Modeling (ABM) to examine the effects of social

complexity on the emergence and dynamism of norms. I argue that this research can help

us to better understand how International Relations theories attempt to explain the

complex dynamics of the international system. I focus specifically on IR explanations for

how states adapt to the social pressures of the international system. I explain why

constructivism is best suited to explain this phenomenon. I also identify its potential

strengths and weaknesses.[25] To do this, I compare the constructivist explanation of

international order—a norms-based approach—to two classic rational materialist

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[25] The current chapter does not intend to provide a detailed overview of the constructivist position in International Relations research. Such a review is beyond the scope of this study. The goal of the current chapter is to provide a broad understanding of the primary differences between constructivism and rationalism. This review focuses on the major theoretical themes that distinguish the two meta-theoretical frameworks from one another from the perspective of IR. The inspiration for this comparative review is drawn from the following constructivist positions: Emanuel Adler, "Seizing the Middle Ground: Constructivism in World Politics," *European Journal of International Relations* 3, no. 3 (1997): 319 -363; Jeffrey T. Checkel, "Review: The Constructivist Turn in International Relations Theory," *World Politics* 50, no. 2 (January 1, 1998): 324-348; Ted Hopf, "The Promise of Constructivism in International Relations Theory," *International Security* 23, no. 1 (July 1, 1998): 171-200; Alexander Wendt, *Social Theory of International Politics (Cambridge Studies in International Relations)* (Cambridge University Press, 1999).

alternatives: neorealism and neoliberalism. These two theories share the same meta-theoretical foundation of rational materialism—herein rationalism—that has served as the dominant paradigm for understanding state behavior within the field of IR for the past few decades.[26] The advantage to rationalism is that it enables the development of testable behavioral hypotheses,[27] which researchers can then use to validate theoretical claims against the empirical record.[28] The weakness of rationalism is that it results in static conceptions of order and an inability to explain the structural dynamism responsible for changes in state behavior over time.[29] I show below why this leads to a theoretical gap in our understanding of the international system—particularly our understanding of how the system evolves—and I demonstrate how constructivism attempts to fill this void.

In the past two decades, the limitations of rationalism have become increasingly apparent within the field of IR. This is because state behavior has evolved in ways that rationalism

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[26] For a detailed review of the rationalist position in IR and an outline of the differences between neorealism and neoliberalism, see David Allen Baldwin, *Neorealism and neoliberalism: the contemporary debate* (Columbia University Press, 1993).

[27] Herbert Gintis, *The Bounds of Reason: Game Theory and the Unification of the Behavioral Sciences* (Princeton University Press, 2009).

[28] Although not a defense of rationalism, a strong argument in favor of falsification within the social sciences is presented within Gary King, Robert Owen Keohane, and Sidney Verba, *Designing social inquiry: scientific inference in qualitative research* (Princeton University Press, 1994).

[29] Alexander Wendt, "Anarchy is what States Make of it: The Social Construction of Power Politics," *International Organization* 46, no. 2 (April 1, 1992): 391-425.

simply cannot explain.[30] Constructivists seized this opportunity to justify a

reinterpretation of international relations. They proposed a sociological norms-based

understanding of state behavior, which they believed could explain both the emergence

and dynamism of international order.[31] Rather than assuming order was a "natural"

equilibrium of the system, constructivists have demonstrated that order is often the result

of sustained social practices that evolve over time.[32] The disadvantage to this explanation

of order is that it leads to complex socio-behavioral assumptions which are difficult—if

not impossible—to confirm.[33] Thus, constructivism achieves theoretical flexibility but

such flexibility often requires researchers to abandon falsification or to limit their

analyses to an overly simplistic and static dimension of dynamic order—norm

conformity.[34] This is an important weakness for constructivism. However, I show that it

is possible to address this weakness using Agent-Based Modeling in the remaining

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[30] Richard Ned Lebow and Thomas Risse-Kappen, *International relations theory and the end of the Cold War* (Columbia University Press, 1995); Pierre Allan, *End of the Cold War: Evaluating Theories of International Relations*, 1st ed. (Springer, 1992).

[31] Alexander E. Wendt, "The Agent-Structure Problem in International Relations Theory," *International Organization* 41, no. 3 (July 1, 1987): 335-370.

[32] Wendt, "Anarchy is what States Make of it."

[33] Andrew Moravcsik, "'Is something rotten in the state of Denmark?' Constructivism and European integration," *Journal of European Public Policy* 6, no. 4 (1999): 669; Maja Zehfuss, *Constructivism in international relations: the politics of reality* (Cambridge University Press, 2002).

[34] Martha Finnemore and Kathryn Sikkink, "International Norm Dynamics and Political Change," *International Organization* 52, no. 4 (October 1, 1998): 887-917; Antje Wiener, "Contested Compliance: Interventions on the Normative Structure of World Politics," *European Journal of International Relations* 10, no. 2 (June 1, 2004): 189 -234.

chapters of this study. On the other hand, the limitation to rationalism is much more severe because it requires a fundamental shift in understanding the basis of international order. This is why I believe constructivism supplies a better framework for explaining how order emerges and evolves within the international system. However, as I show below, constructivists often fail to take full advantage of this bottom-up explanation due to important methodological limitations.

2.2 International Order: The Equilibrium Concept

Our current understanding of the international system is largely built upon a static foundation. This makes it difficult to construct a dynamic theory that can account for change. In this section, I highlight the fundamental problem of change. I describe why change is such a challenging concept to explain from the perspective of IR theory.[35] I argue that our inability to understand change arises from our attempts to reduce a complex social world, such as the international system, into a set of testable research hypotheses. This step is crucial for theory development because the mapping from complexity to simplicity determines the extent to which a theory is capable of explaining change. Obviously, a many-to-many mapping is unhelpful because it is no easier to understand than the system itself, whereas a many-to-one mapping is likely to strip away

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[35] For a more detailed discussion on this problem, see Rosenau, *Turbulence in world politics*.

the characteristics of the system that make it complex and dynamic.[36] To understand

change, we need a theory that lies somewhere in the middle. Throughout this chapter, I

show how the field of IR has shifted between the many-to-many and many-to-one

extremes in a way that has made it difficult to achieve a middle-ground explanation that

is both coherent and capable of understanding change. I argue that this problem stems

from early rationalists attempts to formalize interstate relations in an effort to overcome

the analytical ambiguity of classic IR studies.[37] The rationalist move from a many-to-

many mapping of the system to a many-to-one mapping was important for two reasons.

On the one hand, it set a new standard for IR research built upon a positivist approach to

theory testing. On the other hand, this new standard led to a number of important

theoretical limitations that continue to stifle our understanding of change.

The drawback to the initial many-to-one approach of rationalism was that it attempted to

reduce the complexity of the international system into a single defining feature of

interstate relations. This move was necessary for theory testing but it introduced three

important theoretical barriers to change. First, it required researchers to focus solely on

equilibrium dynamics.[38] In fact, the initial rationalist goal of neorealism was to identify

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[36] John Holland, *Hidden Order: How Adaptation Builds Complexity*, First Edition. (Basic Books, 1996), chap. 1.

[37] Kenneth N. Waltz, *Theory of International Politics*, 1st ed. (Waveland Pr Inc, 2010), chap. 2.

[38] For a detailed discussion on the problem of an equilibrium approach to complex dynamics, see Joshua M. Epstein, *Generative social science: studies in agent-based computational modeling* (Princeton University Press, 2006), chap. 3.

and explain *the single most important equilibria* of the system. Neorealists believed this was the balance of power equilibrium, which appeared to be the dominant pattern of interstate relations at the time.[39] The problem with this approach is that it encouraged theorists to overfit their explanations of state behavior to the current order of the system. This resulted in static conceptualizations of order as the "obvious" outcome of anarchic interstate relations.[40] It also set the terms for validation from the perspective of a theory's ability to hit this one static target. I show below how neoliberals and constructivists have attempted to overcome the former problem. However, the latter validation problem continues to encourage the development of static single-order theories.

The second limitation to the initial many-to-one approach of rationalism is closely related to the equilibrium problem. Because neorealists had overfit their explanations for state behavior to the current order of the system, they failed to understand the emergent dynamics responsible for sustaining this order. Consequently, any deviation from the current order fell outside the scope of neorealist explanation. This led to criticism from neoliberals[41] and then from constructivists[42] who both were able to demonstrate the importance of understanding alternative orders. An additional problem was that

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[39] Waltz, *Theory of International Politics*.

[40] Robert Owen Keohane, *Neorealism and its critics* (Columbia University Press, 1986).

[41] Robert O. Keohane and Joseph S. Nye, *Power and Interdependence*, 2nd ed. (Pearson Scott Foresman, 1989).

[42] Wendt, "Anarchy is what States Make of it."

neorealism could not explain how the system might shift from one equilibrium to another or why the system would fail to attain equilibrium altogether. This is because neorealists used top-down evolutionary logic to justify their claims about state behavior rather than attempting to understand how such behaviors emerged from dynamic bottom-up interactions. This approach led to the development of theories built upon static behavioral assumptions. It also reversed the goal of validation in that researchers tried to demonstrate how the current order of the system caused state behavior as opposed to understanding how state behavior sustained the current order.[43]

The final limitation to the initial many-to-one approach of rationalism is that it recast a diverse social system from the perspective of a single idealized actor. The goal was to identify a basic set of behavioral drivers and this required one to minimize the complications of actor heterogeneity and social interaction.[44] There were two problems with this approach. First, it assumed the behavioral adaptations responsible for the current order of the system were all that were necessary to understand past, present, and future state behavior. This made it impossible to understand how states might adapt in future circumstances neorealists could not foresee. [45] Furthermore, no state in the system actually possessed these idealized behavioral traits and no attempt was made to

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[43] Wendt, "The Agent-Structure Problem in International Relations Theory."

[44] The limitation of this approach is described in Epstein, *Generative social science*, chap. 1 and 2.

[45] Lebow and Risse-Kappen, *International relations theory and the end of the Cold War*.

understand how social interaction impacted behavioral decision-making. Neorealists had

stripped the system of social complexity entirely and the only path to change was through

material means. In other words, neorealism reduced the many-to-many international

system to one macro-pattern at one point in time from the perspective of one idealized

state. Despite these clear limitations, this many-to-one approach set the standard for

theory testing. As I show below, both neoliberals and constructivists have had to counter

this neorealist explanation before they could gain acceptance in the field of IR. Holding

these theories up to this static standard has made it difficult to develop dynamic

understandings of the international system.

The real problem for IR theory is that researchers often overlook the fact that equilibrium

is a dynamic, not static, concept in a complex social system.[46] Yet, IR theorists usually

posit and validate relationships from this static equilibrium perspective. Furthermore,

they rarely ask whether equilibrium is an appropriate representation for their

phenomenon of interest. They simply assume a static equilibrium and proceed to explain

interstate relations solely from this premise. This is certainly true for rationalist theories

but I explain below why constructivism faces this same problem when it comes to theory

testing. The drawback with this approach is that, when one targets a static equilibrium,

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[46] This idea has its roots in the field of Biology, see Stephen Jay Gould, *Punctuated equilibrium* (Belknap Press of Harvard University Press, 2007), chap. 1; H. Peyton Young, *Individual strategy and social structure: an evolutionary theory of institutions* (Princeton University Press, 2001).

one tends to ignore the disequilibrium factors responsible for change.[47] Two things need

to be kept in mind to avoid this problem. First, one should avoid approaching equilibrium

in a complex system from the static perspective.[48] Second, one should not rely solely on

static targets to validate complex dynamics.[49] In the next three sections, I show that

current IR theory has failed to take this advice.[50] I explain why this has led to the

development of static frameworks and an inability to account for change. I then discuss

ways to overcome these limitations in the following chapter.

The remainder of this chapter reviews neorealism, neoliberalism, and constructivism. I

show that each has its limitations for understanding dynamic order. Neorealism and

neoliberalism simply hold too many of the variables of the international system constant.

Their many-to-one mappings of the system result in static understandings of order.

Constructivism, on the other hand, provides a dynamic many-to-some dynamic mapping

but one that struggles to satisfy the static many-to-one validation standard of rationalism.

I argue that the degree to which these limitations impede each framework is largely

dependent upon how the framework explains the emergence of order. For the rationalist

theories of neorealism and neoliberalism, I show that an exogenously defined utility

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[47] Rosenau, *Turbulence in world politics*.

[48] Epstein, *Generative social science*, 2.

[49] Ibid., 3.

[50] For another approach to this topic, see Matthew J. Hoffmann, "Constructing a complex world: The frontiers of international relations theory and foreign policy-making." *Asian Journal of Political Science* 11, no. 2 (December 2003): 37-57.

maximization explanation for the emergence of order forces researchers to recast

theoretical assumptions each time systemic order changes—such as when neoliberals

recast the neorealist understanding of order to account for cooperation. I also explain how

constructivism avoids this problem yet often fails to fully leverage its explanation for the

complex emergence of order in an effort to maintain theoretical falsifiability. Throughout

this discussion, I refer to the EU example introduced in the first chapter to outline the

empirical implications these limitations pose for each framework.

2.3 Neorealist Order: Anarchy and The Balance of Power

The problem of change begins with neorealism. Neorealists were the first to use the

equilibrium metaphor to explain international relations.[51] Their understanding of

equilibrium was highly static. For neorealists, equilibrium was an end state. They were

not interested in explaining how interstate relations reached equilibrium but in simply

outlining the possibilities for state action within the conditions imposed by their supposed

equilibrium.[52] Kenneth Waltz said so himself in his own explanation of the balance of

power equilibrium of neorealism:

> Balance-of-power theory is a theory about the results produced by the
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> uncoordinated actions of states. The theory makes assumptions about the

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[51] Waltz, *Theory of International Politics*, 5.

[52] Wendt, "The Agent-Structure Problem in International Relations Theory."

interests and motives of states, rather than explaining them. What it does

explain are the constraints that confine all states.[53]

Waltz borrowed this equilibrium metaphor from Adam Smith because he believed his

theory could explain how order emerged within the international system without an

orderer. As with Smith, Waltz believed order was the unintended consequence of the

collective action of self-seeking individuals (or states).[54] In opposition to Smith, Waltz

posited a world of competitive disorder in that the actions of states almost always left the

collective worse, not better, off.[55] The system reached equilibrium when states achieved a

material balance of power. This meant that changes in international politics hinged

entirely upon the distribution of material capabilities within the international system. The

variety of political experience was distilled into a single systemic component. Such a

move was acceptable so long as state behavior fit this mold. Nevertheless, it left

everything outside balancing behavior beyond the scope of neorealist explanation.

Neorealism rested on a number of theoretical and methodological commitments that

made it impossible for the theory to explain alternative behavioral equilibria.[56] In the

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[53] Waltz, *Theory of International Politics*, 122.

[54] Ibid., 88-92.

[55] Naeem Inayatullah, "Theories of Spontaneous Disorder," *Review of International Political Economy* 4, no. 2 (July 1, 1997): 319-348.

[56] Keohane, *Neorealism and its critics*.

parlance of game theory, neorealism pre-defined the players (states), the rules of the game (survival), and the payoffs (relative material gains). All that was left to be decided was the distribution of material power. Because of these commitments, the neorealist version of international relations was simply a single-shot Prisoner's Dilemma or Stag Hunt.[57] The Nash equilibrium behavior in this situation was mutual defection, so states were best off ensuring their own security (the security dilemma). Neorealists believed failing to do so would result in elimination from the system. This "as if" assumption— adopted from microeconomic theory and posited based on a single idealized actor— justified freezing international relations as a game of balance of power politics. Waltz himself believed the only thing that could change this situation would be a change in the structure of the system itself, possibly a shift from anarchy to hierarchy.[58] However, neorealist theory could not explain how this would happen.[59] From the neorealist perspective, the system was locked into either competitive disorder or polarity. Nevertheless, it later became apparent that this was not the only order possible in international politics.

Neorealists had identified just one of the countless equilibria configurations of the international system. They then postulated all of their behavioral assumptions from this

[57] The problem with this single-shot approach is highlighted in Robert M. Axelrod, *The complexity of cooperation: agent-based models of competition and collaboration* (Princeton University Press, 1997).

[58] Waltz, *Theory of International Politics*, chap. 6.

[59] Wendt, "Constructing International Politics."

singular perspective. Little effort was made to problematize these basic assumptions.

Neorealists failed to understand how such order could have emerged in different ways.[60]

Furthermore, they were unwilling to accept the possibility of alternative orders.

Neorealists simply argued that self-seeking was the only logical way to behave in an

anarchic system and therefore assumed the system would eliminate all actors who failed

to follow this logic. This idealized and homogeneous explanation for state behavior

eventually led neorealists towards a theoretical dead-end. Throughout the Cold War, a

robust correlation between balance of power assumptions and the empirical record

encouraged neorealists to ignore problems that did not fit within this context. However,

sidestepping gaps in the empirical record became nearly impossible after the fall of the

Soviet Union. Neorealism's explanation for order could not account for the relative lack

of balancing behavior among the remaining global powers at the end of the Cold War.[61]

This limitation was most apparent in Europe where order appeared to emerge and remain

sustainable under an entirely different logic.

Explaining the security behaviors of states should be an easy task for neorealism.

However, it is much harder to explain this phenomenon from the neorealist perspective

when we consider the EU case. One reason is that the very existence of the EU highlights

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[60] In a complex social system, it is possible for multiple explanations to account for the same equilibrium result. This is why the top-down approach fails to justify the theoretical validity of one's claims. For further discussion on this topic, see Joshua M. Epstein, Robert Axtell, and 2050 Project, *Growing artificial societies: social science from the bottom up* (Brookings Institution Press, 1996), chap. 1-3.

[61] Lebow and Risse-Kappen, *International relations theory and the end of the Cold War*.

a primary flaw in the neorealist interpretation of order and state behavior. Neorealists cannot explain the EU integration project from the perspective of a balance of power order.[62] The level to which the states of Europe have pooled sovereignty violates the core neorealist principle that states will seek to maintain survival and political independence at all cost.[63] The continued widening and deepening of political integration after the fall of the Soviet Union further undermines the neorealist position.[64] Neorealism can provide a logical rationalization for why EU integration has faced internal resistance in the security realm but it cannot account for the push towards greater interdependence in almost all other areas of politics absent a common hegemonic threat.[65] Neorealism ultimately predicted the opposite of what has actually occurred in the EU in the past few decades.[66] This is because the static order neorealism observed during the Cold War has changed in ways that are inconceivable to the theory itself. Thus, although neorealism has traditionally been the obvious choice for security studies it turns out to be the least satisfactory theory for understanding EU member state behaviors.

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[62] Simon Collard-Wexler, "Integration Under Anarchy: Neorealism and the European Union," *European Journal of International Relations* 12, no. 3 (2006): 397 -432.

[63] Waltz, *Theory of International Politics*.

[64] Bill McSweeney, *Security, identity and interests: a sociology of international relations* (Cambridge University Press, 1999), chap. 1.

[65] Collard-Wexler, "Integration Under Anarchy."

[66] John J. Mearsheimer, "Back to the Future: Instability in Europe after the Cold War," *International Security* 15, no. 1 (July 1, 1990): 5-56.

2.4 Neoliberal Order: Anarchy and Institutional Cooperation

Neorealists commit a common error in their understanding of the international system. It is one we see recurring throughout IR. Neorealists mistook a temporarily stable international order for a "natural" equilibrium of the system. This was a reasonable assumption at the time the theory was developed because it was not until over a decade later that the balance of power order came into serious question. However, neorealism faced criticism long before the Cold War ended. A major problem with neorealism was that it could not foresee any equilibrium other than the competitive balance of power emerging from anarchy. Neorealists failed to understand that the same behavioral assumptions (self-help) that led to interstate competition could also lead to the opposite ordered conclusion (cooperation). Neoliberals were the first to highlight this problem as they outlined the possibility for an emergent cooperative equilibrium in interstate relations.[67] To do this, neoliberals simply used the same behavioral rules of neorealism (rational materialism) to play a different "game" of international politics. The goal of neoliberalism was to explain how cooperation emerged from self-help and anarchy.

Neoliberals posited the same explanation for self-help as neorealists. The pursuit of self-interest was simply a logical starting point for individual or state behavior. The difference between the two is that neoliberals believed self-help could lead to mutual gains and that such gains could foster interstate cooperation. To explain how such cooperation could

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[67] Keohane and Nye, *Power and Interdependence*.

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emerge, neoliberals first broadened the spectrum of state interests to include absolute

gains alongside the neorealist relative gains. They then argued that states would pursue

absolute rather than relative gains if they could establish institutional mechanisms to

ensure cooperation over defection. Robert Keohane and Joseph Nye proposed three

reasons why this would occur in an anarchic international system.[68] First, they argued

that multiple interaction channels existed among states and that within these channels

societies could pursue interests beyond the security realm. Second, they dismissed the

neorealist assumption that security was hierarchically dominant to all other issues.

Finally, they claimed that issue linkage in areas other than the military dimension could

lead to a diminishing role for security interests, encouraging states to establish formal

institutional arrangements so as to lock in mutual gains. It was from this perspective that

neoliberals began to explain how states could secure cooperative orders that fell outside

the balance of power purview.

Another major contribution of neoliberalism was its ability to recast neorealism's single-

shot Stag Hunt into an iterative game.[69] This resulted in a slightly more dynamic

understanding of order. The introduction of a temporal component redefined the

international political decision-making landscape. In the single-shot game, uncertainty

dominates the player's choices and thus encourages mutual defection despite the potential

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[68] Ibid., chap. 2.

[69] The advantage of iterative relations for cooperation is outlined in Axelrod, *The complexity of cooperation*.

for greater absolute gains. Iteration reduces uncertainty because it allows for the development of a norm of reciprocity.[70] Players get to know the tendencies of others and can use this information to their advantage in future interactions. Thus, despite the initial individual pursuit of self-interest, players could collectively overcome the sub-optimality of defection to engage in cooperative action. The simple addition of a shadow of the future allows states to shift from the competitive balance of power equilibrium of neorealism to the cooperative and Pareto-optimal equilibrium of neoliberal institutionalism. Neoliberals introduced the concept of international regimes to explain where and when this form of cooperative self-help behavior was likely to occur.

Stephen Krasner provides a broad definition of international regimes as "principles, norms, rules, and decision-making procedures around which actor expectations converge in a given issue area."[71] Of course, this definition is open to a wide range of interpretations but neoliberals typically focus on its functional aspect. Neoliberals believed international regimes made it possible for states to commit to coordinated action for mutual gain.[72] Informally, cooperation is possible because states can rely on the routine behaviors that occur within regimes when calculating a best course of action.

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[70] Ernst B. Haas, "Why Collaborate?: Issue-Linkage and International Regimes," *World Politics* 32, no. 3 (April 1, 1980): 357-405.

[71] Stephen D. Krasner, "Structural Causes and Regime Consequences: Regimes as Intervening Variables," *International Organization* 36, no. 2 (April 1, 1982): 185.

[72] Robert O. Keohane, "The Demand for International Regimes," *International Organization* 36, no. 2 (April 1, 1982): 325-355.

Formally, regimes supply the sanctioning mechanisms and/or organizational capabilities

necessary to enable these coordinated interactions. The important point to note is that

neoliberals posit regimes (formal or informal) as the products of shared state interest.

Thus, the cooperative order that develops within a regime is often considered issue-

specific and functional. Complex interdependence may encourage cooperative spillover

into other issue areas but this is always assessed in terms of the gains states accrue from

further cooperation. Ultimately, states were the final arbiter so the gains of cooperation

had to outweigh the costs. In sum, neoliberals believed cooperation could emerge

whenever such a situation occurred in a given issue area.

There are two major drawbacks to the neoliberal interpretation of order. Both overlap

with neorealism. The first limitation is that neoliberals must begin their explanation of

order with a set of exogenously defined assumptions about state behavior. Because

neoliberalism is built upon a rationalist core, it is necessary to specify one's behavioral

assumptions prior to analysis.[73] Neoliberals fail to fully problematize state interest. They

assume "obvious" domestic wants dictate international actions and that states will only

agree to institutional restraint if it results in even greater domestic gains.[74] Behavioral

change therefore must stem from either shifts in domestic wants, which fall outside the

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[73] Andrew Moravcsik, "Taking Preferences Seriously: A Liberal Theory of International Politics," *International Organization* 51, no. 4 (1997): 513-553.

[74] For a critique of this approach, see John Gerard Ruggie, "International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order," *International Organization* 36, no. 2 (April 1, 1982): 379-415.

neoliberal scope of explanation, or the establishment of new institutional restraints. The second drawback to neoliberalism is that its claims about cooperative order are primarily limited to interactions within a given regime or institution. Neoliberals depict regimes and institutions solely as instruments of the state due to their commitment to methodological individualism.[75] States may come to redefine their interests in terms of new institutional possibilities but their preferences for material gain are expected to remain constant over time. To understand why these two drawbacks lead to a gap in our theoretical understanding of order, we can again turn to the EU security behavior example from above.

When it comes to EU security behaviors, neoliberalism is not prone to the same integration flaw as its rational materialist counterpart neorealism. In fact, neoliberalism actually serves as the foundation to a number of important integration theories, from the early works of neofunctionalism[76] to the more recent works of liberal intergovernmentalism[77] and various strands of new institutionalism.[78] Neoliberalism thus

[75] For a critique of this approach, see Emanuel Adler, "Imagined (Security) Communities: Cognitive Regions in International Relations," *Millennium - Journal of International Studies* 26, no. 2 (June 1, 1997): 249 -277.

[76] Ernst B. Haas, *The uniting of Europe; political, social, and economic forces, 1950-1957* (Stanford University Press, 1968).

[77] Andrew Moravcsik, *The Choice for Europe: Social Purpose and State Power from Messina to Maastricht* (Cornell University Press, 1998).

[78] Mark Aspinwall and Gerald Schneider, *The rules of integration: institutionalist approaches to the study of Europe* (Manchester University Press, 2001); Mark A.

provides a more promising route to a rational materialist explanation of EU member state behavior than neorealism. However, the strength of neoliberalism can also be a weakness when it comes to understanding EU security behaviors. This is because neoliberalism, particularly liberal intergovernmentalism, focuses most of its efforts on explaining the institutional consequences of strategic bargaining. The problem with this approach is that security has been the least institutionalized of all EU issue sectors.[79] As with neorealism, neoliberalism can certainly explain why security integration has proceeded in fits and starts but it has much less to say about behaviors that, for the time being, fall outside the EU governance realm. The relatively limited reach of the EU's Common Foreign and Security Policy pillar makes it difficult to apply the neoliberal institutional bargaining argument to current member state security behaviors.

The EU member states remain relatively autonomous actors when it comes to security decision-making, despite the fact that there have been important institutional strides in this area. Two significant changes include the now legally binding nature of the Common Foreign and Security Policy (CFSP) and the introduction of Qualified Majority Voting (QMV) into a wider range of foreign policy decisions after the Maastricht Treaty.[80] The

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Pollack, *The Engines of European Integration: Delegation, Agency and Agenda Setting in the European Union* (Oxford University Press, USA, 2003).

[79] Ben Tonra and Thomas Christiansen, *Rethinking European Union foreign policy* (Manchester University Press, 2004), chap. 3; Michael Eugene Smith, *Europe's foreign and security policy: the institutionalization of cooperation* (Cambridge University Press, 2004), chap. 1.

[80] Smith, *Europe's foreign and security policy*.

fact that the EU member states continue to take steps to strengthen the CFSP highlights a

convergence of interest in the foreign policy realm. The introduction of QMV goes even

further than mere interest convergence, showing that member states are willing to cede

sovereignty to a limited extent to achieve more efficient foreign policy outcomes.

However, these institutional changes have yet to significantly impact the autonomy of

security decision-making for each member state for a number of reasons. First, although

QMV is possible, consensus decision-making is the norm. Second, this same consensus

norm also encourages policy-makers to avoid hard bargaining and issues considered part

of state's *domaine réservé* when it comes to foreign policy decision-making. In other

words, the scope of foreign policy decision-making open to institutional bargaining is

extremely limited. This is further amplified by the fact that European Security and

Defense Policy remains entirely outside of current CFSP agreements. Thus, EU

governance in the realm of security is largely based upon informal coordination and

ultimately an institutional mechanism member states are free to override.

2.5 Constructivist Order: Anarchy and Social Structure

Most IR theories begin from the premise of systemic anarchy. In an anarchic system,

order is emergent not centrally contrived. Order results when autonomous units establish

patterned interactions. Patterned interactions are crucial to our understanding of

international relations. They make prediction and explanation possible. Yet, patterned

interactions also pose a potential theoretical trap. They convey a false sense of systemic

stability. Researchers need to be careful not to overfit theories to the current order. Such an approach makes it impossible to account for future systemic change. This is especially true for theories that rely on linear assumptions to explain systemic order. Once the rules of the interaction are set, the system becomes deterministic. The only way to avoid determinism is to allow the rules themselves to change. Order is then dependent upon adaptation and co-evolution. In this case, the international system more closely resembles a complex adaptive system rather than a deterministic anarchic system. In this section, I argue the former is a better representation of the international system than the latter. I also explain why constructivism is a better theoretical framework for understanding this complex dynamic system than the rational materialist theories of neorealism and neoliberalism outlined above.

I have shown in the previous two sections how the rational materialist theories of neorealism and neoliberalism result in static conceptions of order. This is because both define order as an equilibrium that results from the interactions of idealized self-seeking states. In other words, both pre-determine the order that can emerge in an anarchic system by fixing the rules of behavior to fit their equilibria of interest. Such a move leads to linear and single-path understandings of order. This severely limits the scope of explanation for rationalist theories in two ways. First, as was shown with neorealism, an extremely narrow and fixed conception of state interests makes it impossible to explain alternative orders or to anticipate changes in order over time. Second, as was shown with neoliberalism, it only makes sense to depict states as strategic bargainers when states are

in a position to bargain. This means that states must both know what they are trying to achieve—which in itself is often debatable[81]—and they must be in a position to achieve this objective through institutionalized means. Essentially, rationalism's top-down explanation for order results in a number of important theoretical gaps that constructivist research can fill.

Constructivism, like rationalism, is a meta-theoretical framework that can be applied to a wide range of theoretical or empirical problems. However, the constructivist approach to understanding order is fundamentally different from rationalism. The core tenets of constructivism are bottom-up as opposed to top-down. This allows for a more dynamic conception of international order as both an emergent and evolving phenomenon. Constructivism achieves this theoretical flexibility in two ways. First, constructivism rejects the materialist foundation of neorealism and neoliberalism, which sees material gains and losses as the sole driver of state behavior. Constructivism focuses instead on the ideational motivations for behavior such as norms and identities.[82] Second, constructivism problematizes interest formation rather than accepting an exogenous definition of state preferences. In this way, constructivism defines both state interests and order as emergent and process-dependent features of the international system that are

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[81] Martha Finnemore, *National interests in international society* (Cornell University Press, 1996).

[82] Adler, "Seizing the Middle Ground."

open to change over time.[83] Thus, constructivism can explain a much wider and more complex array of state behavior than rational materialism.

The constructivist framework allows researchers to conceive of states as dynamic and socially adaptive actors rather than deterministic automata. Order is thought to emerge when states adapt to the same social context.[84] The key difference between this conceptualization of order and the static order of neorealism and neoliberalism is that states adapt to both material and social pressures. Constructivism posits the mutual constitution of reality as the driver of this adaptation. This process determines how states come to understand both the material and non-material world through social interaction. Constructivism claims that shared conceptions of reality shape state interests much more than material capabilities alone.[85] This is because states must rely on their current social context to determine which actions are feasible, possible, or expected in the international system. Thus, before states can conceivably use cost-benefit analysis to calculate a best course of action, they must first internalize a reliable subjective understanding of the world. Constructivists believe norms are the primary mechanism through which this internalization unfolds.[86] Norms represent the current socially agreed upon understanding

[83] Finnemore, *National interests in international society*.

[84] Wendt, "Constructing International Politics."

[85] Wendt, "Anarchy is what States Make of it."

[86] Jeffrey T. Checkel, "Norms, Institutions, and National Identity in Contemporary Europe," *International Studies Quarterly* 43, no. 1 (March 1, 1999): 83-114.

of reality. This social agreement can encompass a wide range of ideas, meanings, or expectations about the world and others. States use this normative agreement to learn from their social interactions. Norms help states to maintain subjective consistency with the complex and dynamic world that surrounds them. Constructivists believe it is through this complex social feedback loop that order emerges in the international system.

There are two important points to highlight about the constructivist explanation for emergent order. First, normative order is an intersubjective phenomenon. In other words, order is an aggregate social property of the international system not an individual state-level property.[87] Norms require social agreement to exist so isolated individual state interpretations have only a minimal impact on the emergence and dynamism of order. This means that behavioral heterogeneity can exist despite the presence of a normative order because the order itself is not the product of pre-determined rules of behavior. Of course, for a norm to be a norm only a certain level of deviance is possible or the order will eventually dissolve due to lack of social consensus. Second, a normative order requires continued practice to remain sustainable over time.[88] This is because norms are social products not individual behavioral properties. Every state participates in shaping this social context and this social context in turn shapes every state. Individual states take actions they believe to be appropriate based upon their current understanding of the international system and these actions then redefine the social context they and others use

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[87] Wendt, "The Agent-Structure Problem in International Relations Theory."

[88] Finnemore and Sikkink, "International Norm Dynamics and Political Change."

to interpret their own world in future interactions. This is why every normative order is only as stable as the social feedback that supports it. If this feedback shifts (if states begin to act upon new understandings of the world), the order of the system changes. It is in this way that constructivists accommodate change within their explanation for emergent order.

The advantage of the constructivist interpretation of order is that it is possible to conceive of order as a metastable phenomenon—order that retains stability in the short term but evolves in the long run. This is because normative order is the result of a dynamic self-sustaining process. However, constructivists often fail to take full advantage of this dynamism in their research. Most constructivist studies focus on norm conformity in an effort to justify the impact of norms on state behavior. This is necessary for two reasons. First, norms are epiphenomenal so constructivists need to show that states do in fact conform despite potentially prior deviance. Second, constructivism arose within the field of IR under the shadow of rationalism. Thus, constructivists often framed their explanations for state behavior as an alternative to the rationalist standard. The classic constructivist approach was to identify a norm that fell outside the rationalist purview and then demonstrate conformity to the norm as a way to validate a constructivist reinterpretation. This approach to validation has led to both a crucial misinterpretation of constructivist claims and a limited understanding of the dynamic nature of norms.

Critics of constructivist research often highlight two potential weaknesses. First, critics point to norm violations to argue against a constructivist interpretation of state behavior. This criticism typically comes from rationalists who claim that states override norms whenever it is in their self-interest to do so.[89] The validity of this criticism often hinges upon whether one accepts the rationalist premise as the default justification for state behavior. This is because deviance to norms fits within a constructivist understanding of order, so norm violations do not automatically invalidate constructivist claims. Constructivists can always address such criticism by explaining that norms are not the only factor that impacts state behavior—whereas a focus solely on rational materialism does miss the impact of norms. The biggest drawback to this defense is that constructivism fails to explain when or why violations to the norm occur. This is largely due to the second major weakness of constructivism.

The second criticism of constructivism is much harder to overcome than simply outlining the possibility for deviance within a normative order. This criticism centers upon the relative absence of theoretical assumptions within the paradigm.[90] After all, constructivism is a framework for understanding international relations and/or state behavior not a theory in itself. Therefore, a major drawback to constructivism is that it lacks a formal specification for the mechanisms of norm internationalization. This makes

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[89] Vaughn P Shannon, "Norms Are What States Make of Them: The Political Psychology of Norm Violation," *International Studies Quarterly* 44, no. 2 (June 1, 2000): 293-316.

[90] Checkel, "The Constructivist Turn in International Relations Theory"; Moravcsik, " 'Is something rotten in the state of Denmark?"

it difficult to understand exactly how states come to adopt new norms or to explain how old norms replace new norms within the international system.[91] The entire socialization process remains somewhat of a black-box concept without a clear way to operationalize norm internalization. Constructivists often attempt to overcome this problem using 'thick description' and 'process tracing' to outline specific instances of norm adoption or change within the empirical record.[92] However, this narrow focus on particularized and historically contingent normative orders rarely lends itself to generally applicable theoretical assumptions. Furthermore, constructivists must also limit the scope of such studies to the conformity dimension. This is done to avoid unnecessary theoretical and empirical confusion. I explain in the remainder of this study how to address both of the above criticism of constructivism using complexity theory and Agent-Based Modeling. However, before getting to this discussion, I first compare a constructivist interpretation of the EU to the rational materialist interpretation outlined in the previous two sections.

The strength of constructivism lies in its ability to explain changes in state behavior over time. To see why this is important, we can compare a constructivist interpretation of EU security behaviors to a rationalist alternative. The primary difference between a constructivist and rationalist explanation is that the former focuses on the emergence of actor preferences while the latter assumes fixed preferences. This has major

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[91] Matthew J. Hoffmann, *Ozone depletion and climate change: constructing a global response* (SUNY Press, 2005), chap. 3.

[92] A review of constructivist research methods can be found in Klotz, Audie and Cecelia Lynch, *Strategies for research in constructivist international relations* (M.E. Sharpe, 2007).

consequences for our approach to understanding EU security behaviors. Constructivists assume that security preferences evolve through social practice and that actions will often stem from the member state's current understanding of what it means to be "European."[93] Rationalists, on the other hand, assume EU member states always calculate a best course of action using fixed national preferences as a guide to decision-making.[94] The obvious implication here is that constructivists see the EU as a sphere for socialization while rationalists see it solely as an arena for political gain. Thus, if we take the constructivist approach, the security behaviors of EU member states can evolve and possibly align over time but, if we take the rationalist approach, EU member states must always act in a consistent self-seeking manner to address international security issues, unless bound by institutional commitments. I have already shown above how the fixed-preferences approach limits neorealism and neoliberalism in the realm of EU security. I believe constructivism can potentially fill this gap but current constructivist research must do more to fully account for the complex and dynamic process of norm internalization within the EU.

The advantages of a constructivist interpretation of the EU case are twofold. First, constructivism is applicable to the study of EU security behaviors regardless of the status of integration. Whereas neorealists view the EU as a temporary security alliance and

[93] Thomas Risse, *A Community of Europeans?: Transnational Identities and Public Spheres* (Cornell University Press, 2010).

[94] For a critique of this approach, see Checkel, Jeffrey T. "Constructing European Institutions" in Aspinwall and Schneider, *The rules of integration*, chap. 2.

neoliberals view the EU as a sanctioning body or multi-level governance structure, constructivists view the EU as a social context.[95] Thus, unlike neorealism, constructivism can account for the current integrative order in Europe as a product of sustained cooperative practice. Furthermore, unlike neoliberalism, constructivism's theoretical reach is not limited to institutional bargaining. This means that constructivism can explain behaviors that fall outside the multi-governance realm, such as the independent security actions of member states. Constructivism provides a framework for understanding how national preferences are shaped within the EU absent binding agreements set down in the treaty or constitutional process. Although the EU has yet to secure strong institutional commitments in the realm of security and recent domestic opposition to the constitutional process has led to questions about the EU's ability to act as a supranational actor, constructivists have shown that the EU can still play a significant role in shaping the preferences and behaviors of member states. This is because the EU is both a social and political arena. Socialization within the EU helps member states to "discover" their preferences through interactions with, or observations of, other EU members. Member states look to the actions of other member states to

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[95] Jeffrey T. Checkel, "Why Comply? Social Learning and European Identity Change," *International Organization* 55, no. 3 (July 1, 2001): 553-588; Maria Green Cowles, James Caporaso, and Thomas Risse, *Transforming Europe : Europeanization and Domestic Change* (Cornell University Press, 2001); Ian Manners, "Normative Power Europe: A Contradiction in Terms?," *JCMS: Journal of Common Market Studies* 40, no. 2 (2002): 235-258; Pernille Rieker, *Europeanization of national security identity: the EU and the changing security identities of the Nordic states* (Taylor & Francis, 2006); Frank Schimmelfennig, "The Community Trap: Liberal Norms, Rhetorical Action, and the Eastern Enlargement of the European Union," *International Organization* 55, no. 1 (2001): 47-80.

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understand what it means to be "European." The sustained practice of ordered behaviors leads to the emergence of EU norms and the formation of a common European identity.[96] It is in this way that the EU impacts member state behavior without formal institutional commitments.

The second advantage of a constructivist interpretation of the EU case is that it allows for a more nuanced understanding of security. Because constructivism captures the non-material aspects of state behavior, it is possible to investigate the ideational component of EU security. This is important for two reasons. First, EU security actions conducted in the past two decades do not fit classic neorealist balance of power logic.[97] Rather than balancing against one another or forming a collective security alliance to offset US hegemony after the fall of the Soviet Union, Europe remains largely committed to NATO for traditional security measures while the member states themselves have only resorted to force to address "non-traditional" security concerns. Therefore, it is necessary to adopt a "wider" understanding of security than the traditional "narrow" conception—which focuses solely on existential military concerns—if we are to understand how the EU is likely to respond to security crises.[98] Widening the scope of security allows us to use

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[96] Tyler M. Curley, "Social Identity Theory and EU Expansion.," *International Studies Quarterly* 53, no. 3 (2009): 649-668; Rieker, *Europeanization of national security identity*.

[97] Collard-Wexler, "Integration Under Anarchy."

[98] The argument for a wider conceptualization of security is outlined in Barry Buzan, Ole Wæver, and Jaap de Wilde, *Security: a new framework for analysis* (Lynne Rienner Publishers, 1998).

constructivism to understand how EU member states socially construct or securitize

threats. This is important because EU member states have been selective both in

determining which security threats should be addressed and in their approach to

addressing these problems.[99] To understand this process, we need to examine how EU

member states have adapted to their evolving social context and constructivism is the

most appropriate framework for such an endeavor.

2.6 Conclusion

In this chapter, I have outlined three explanations for order in the international system.

The first two sections focused on rationalist explanations for order. Both of these

explanations assumed order was the consequence of states acting upon fixed and

intuitively obvious national interests. Neorealists believed interactions among states

attempting to maximize relative security gains led to a balance of power order. This

explanation for order was limited to a single equilibrium at a single point in time from the

perspective of a single idealized actor. Neoliberals modified this single-order perspective

to explain the existence of cooperative order. Rather than focusing solely on relative

gains, neoliberals described how states secure absolute gains outside the security realm

through the establishment of formal institutional commitments. Thus, neoliberals were

able to extend the rationalist perspective to include multiple equilibria. Finally, the

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[99] The social construction of security threats and the process of securitization is described in Balzacq, Thierry, "Securitization Theory: How Security Problems Emerge and Dissolve (Paperback)".

constructivist explanation problematized both the interests of states and the order that emerges through social interactions. In this way, constructivism was able to explain both the ideational component of order and its dynamic nature. Constructivism has the greatest potential for understanding the complex and dynamic evolution of state behaviors but most constructivist studies to this point have depicted normative order as if it were as fixed and universally path-dependent as prior rationalist explanations.

The current chapter has argued that, although constructivism promises a dynamic theory of the international system, it often fails to fulfill this promise. This is because constructivism is a meta-theoretical framework like rationalism. It provides general guidelines for formulating theoretical assumptions about the world. Its advantage over rationalism is that it keeps more of the moving parts of the system moving. However, to this point, constructivism lacks a theoretical equivalent to neorealism or neoliberalism. Therefore, in order for constructivism to move from the realm of meta-theory to theory, it is necessary to devise a set of assumptions about the micro-mechanisms of the system responsible for the macro-patterns constructivists seek to explain. Furthermore, constructivists also need to avoid falling into the same methodological trap that neorealists and neoliberals fall into when they attempt to validate their theoretical claims. Some constructivists avoid this problem entirely by not testing their claims while others reduce their validation aims to static unidimensional targets to reduce the complexity of theory testing. This is why the current study focuses on the methodological problems of constructivism as a way to overcome its limitations. Two things need to be done to

accomplish this goal. First, we need a clear specification of behavioral assumptions built upon constructivist principles. Second, we need a method to test these behavioral assumptions which allows us to investigate the dynamism inherent within this complex understand of the international system. In the remaining chapters of this study, I show how to achieve these two goals.

3. THE NORMSIM FRAMEWORK

3.1 A Framework for Self-Sustaining Order and Change

International relations are inherently dynamic. Yet, as I have shown in the previous

chapter, our frameworks for understanding IR problems are relatively static. This is

because the field of IR strongly prefers parsimonious to complex explanations. In this

chapter, I show how the quest for parsimony can impede our ability to understand the

evolutionary character of complex social systems such as the international system. I have

discussed the limitations of the static approach to IR in the previous chapter. I have also

outlined a number of potential dynamic solutions. I now bring these components together

to propose a dynamic framework of the international system. Although intended for an

economics audience, H. Peyton Young comes the closest to describing the objective of

this chapter as he makes the case for the use of dynamic frameworks to explain complex

systems:

> Neoclassical economics describes the way the world looks once the dust
>
> has settled; we are interested in how the dust goes about settling. This is
>
> not an idle issue, since the business of settling may have considerable
>
> bearing on how things look afterwards. More important, we need to

recognize that the dust never really does settle—it keeps moving about,

buffeted by random currents of air.[100]

The obvious modification to Young's statement is that the framework proposed within

this chapter is directed at the field of IR. Thus, the "neo's" I refer to are those of

neorealism and neoliberalism. However, I believe it is also necessary to make another

subtle but crucially important modification to Young's stated objective. Rather than

relying on "random currents of air" to explain the flux of international politics, I

explicitly define these elements based upon a more refined understanding of the socio-

structural complexity of international affairs. As a result, the proposed framework

demonstrates how both order and change become self-sustaining processes within the

international system. I argue that the field of IR offers some interesting insight into the

mechanisms of generative order but has largely ignored the mechanisms of disorder

responsible for long run change. The proposed framework fills this theoretical gap.

The purpose of the NormSim framework is to replicate three well-known characteristics

of complex adaptive systems, which I believe aptly apply to international relations: 1)

local conformity, 2) global diversity, and 3) punctuated equilibria.[101] First, I argue that

much of the order we see in the international system is local not global. This is

particularly true for recurring patterns in interstate relations tied to norm-following

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[100] Young, *Individual strategy and social structure*, 4.

[101] Ibid., chap. 1.

behavior. The important point to keep in mind is that I use the term "local" loosely. I discuss the effects of spatial locality but the notion of locality is entirely dependent how a social interaction sphere is defined. Second, I explain why global diversity tends to prevail in the international system. I describe a number of disordering principles that prevent the system from settling upon a homogeneous behavioral equilibrium. I focus specifically on the ways in which normative structures overlap to provide exposure to new norms. Finally, I explain why the dynamics of political evolution follow a pattern of punctuated equilibria. I introduce two important concepts, Herbert Simon's near decomposability[102] and Claudio Cioffi-Revilla's canonical theory of social complexity,[103] to propose how states might cope with this dynamic.

I believe the best way to address the three defining characteristics of international politics is to bracket the opposing forces of meta-stability into ordering and disordering principles and then discuss the ways in which these forces interact. Therefore, I first outline the ordering principles of generative behavioral equilibria from the context of prior IR theory. I use social constructivism as the primary theoretical inspiration for this work. Next, I examine the disordering principles responsible for disrupting the expected normative order of constructivism. I draw upon the works of complexity theory, evolutionary economics, and artificial intelligence to support this discussion. Finally, I

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[102] Herbert A. Simon, *The Sciences of the Artificial - 3rd Edition*, 3rd ed. (The MIT Press, 1996), chap. 8.

[103] Claudio Cioffi-Revilla, "A Canonical Theory of Origins and Development of Social Complexity," *The Journal of Mathematical Sociology* 29, no. 2 (2005): 133.

combine the ordering and disordering principles into a comprehensive framework. I then test this framework using an Agent-Based Model in the following chapters. I begin now with a justification for a complexity-inspired framework of the international system.

3.2 The International System as a Complex Adaptive System

If we want to understand the long run behavior of adaptive actors such as states, we need to view the international system as a complex adaptive system.[104] A static understanding of the world is unhelpful for this endeavor. It can only tell us how states are likely to solve problems using fixed preferences to search for Nash equilibria when the rules of the game are well defined.[105] This is useful for understanding simplistic short run behavior but it overlooks critical areas of change in the long run.[106] Bounded rationality introduces a degree of flexibility in this approach but it leaves the path to change somewhat open to chance—actors simply make mistakes in their rational decision-making and the system shifts to a new equilibrium without a clear explanation for the direction of change.[107] I

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[104] For a review of this argument, see Axelrod, *The complexity of cooperation*; Lars-Erik Cederman, *Emergent actors in world politics: how states and nations develop and dissolve* (Princeton University Press, 1997); Hoffmann, *Ozone depletion and climate change*; Rosenau, *Turbulence in world politics*; William R. Thompson, *Evolutionary interpretations of world politics* (Psychology Press, 2001).

[105] Limitations to this approach are discussed in Hargreaves Heap, Shaun P. and Yanis Varoufakis, *Game Theory: A Critical Introduction*, (Routledge 1995).

[106] John H. Miller and Scott E. Page, *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*, illustrated edition. (Princeton University Press, 2007), chap. 10.

argue that there is more to the dynamism of the international system than chance alone. The dynamism of the international system comes from the adaptability of its political actors. The primary objective of this chapter is to explain what it is these actors are adapting to and why adaptations are likely to take one path and not another.

A complex adaptive systems explanation of international relations requires a good deal of theoretical and methodological complexity relative to the standard IR approach. It may not be obvious from the outset that complexity is preferable to parsimony. One may acknowledge the limitations of static theory outlined in the previous chapter while, at the same, fear the loss of analytical clarity in the move to a complex framework. I admit this is a valid concern but I also argue that it is possible to control for this problem and gain theoretical leverage while doing so. I describe in detail how to accomplish the latter goal in the next two chapters while I focus on the theoretical gains in this chapter. I highlight the need for a complex adaptive systems framing of international relations. I show that this is necessary because certain phenomena are simply impossible to explain absent a

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[107] The strength of bounded rationality is entirely dependent upon its theoretical foundation. Therefore, a simple stochastic model of bounded rationality driven by mistakes in logic is clearly limited in its ability to explain how mistakes are made. For a more detailed treatment of bounded rationality, see W. Brian Arthur, "Inductive Reasoning and Bounded Rationality," *The American Economic Review* 84, no. 2 (May 1, 1994): 406-411; Daniel Kahneman, "Maps of Bounded Rationality: Psychology for Behavioral Economics," *The American Economic Review* 93, no. 5 (December 1, 2003): 1449-1475.

dynamic framework. This is true for all "emergent" phenomena within a complex

adaptive system.[108]

What is the key emergent phenomenon of international relations that cannot be explained

using a traditional framework? The answer is social norms. Understanding the role of

norms and norm change in international politics requires a complex adaptive systems

(CAS) approach.[109] This is true for two reasons. First, norms are more than the sum of the

individual parts of a social system. Normative structures are diverse, dynamic, open to

competing interpretations, and they evolve over time. As opposed to the exogenously

defined material structures of neorealism and neoliberalism, norms are dependent upon

social practice for their existence. Norms come into being through social agreement and

remain in place through sustained conformity. Thus, norms are emergent aggregate

properties whose existence depends entirely upon actions at the individual level but

whose dynamics are contingent upon collective—not individual—change.[110] In this way,

norms take on a life of their own that is somewhat, although not entirely, divorced from

the individual-level properties of the system. Therefore, it is crucial to understand both

[108] The complexity of emergent phenomena is described in the following works,
Cederman, *Emergent actors in world politics*, chap. 1; Epstein, *Generative social science*,
chap. 2; John H. Holland, *Emergence: From Chaos To Order* (Basic Books, 1999), chap.
1; Miller and Page, *Complex Adaptive Systems*, chap. 1.

[109] For an alternative CAS-based approach to norms, see Hoffmann, *Ozone depletion and
climate change*, chap. 3; Thompson, *Evolutionary interpretations of world politics*, chap.
6.

[110] Hoffmann, *Ozone depletion and climate change*, chap. 3; Thompson, *Evolutionary
interpretations of world politics*, chap. 6.

how norms shape individual action and how individual action shapes norms. Such an understanding is not possible with static frameworks that strictly divide agency from structure. [111] The only way to overcome this limitation is to endogenize agency and structural change within one's framework.

The second reason for a CAS approach is based on the fact that norms are the product of adaptive not determined systems.[112] Norm emergence, conformity, and change are all bottom-up processes. Each process involves multiple individual adaptations that, in the aggregate, result in complex macro-level dynamics. To explain which path the system is likely to take, we need to understand how adaptation unfolds in a complex social system. The social aspect of adaptation is extremely important in this context. Social actors must adapt to the adaptations of other actors, not just to the realities of a materially fixed environment. Co-adaption produces nonlinear dynamics.[113] Such dynamics are impossible to detect or understand using static frameworks. The causes of change are often indirect and multiplicative as opposed to the direct and additive effects of deterministic structures. This makes it difficult, although not impossible, to follow the long run trajectory of norms. Nevertheless, it is still possible to outline the major

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[111] Wendt, "The Agent-Structure Problem in International Relations Theory."

[112] Robert Axelrod, "An Evolutionary Approach to Norms," *The American Political Science Review* 80, no. 4 (December 1, 1986): 1095-1111; H. Peyton Young, "The Evolution of Conventions," *Econometrica* 61, no. 1 (January 1, 1993): 57-84; Elinor Ostrom, "Collective Action and the Evolution of Social Norms," *The Journal of Economic Perspectives* 14, no. 3 (July 1, 2000): 137-158.

[113] Miller and Page, *Complex Adaptive Systems*, chap. 2.

characteristics of norm dynamics because IR norms share many of the same systemic features as other complex adaptive phenomena.[114] The NormSim framework applies a general understanding of emergence, self-organization, and metastability within an IR context to describe the complexity of international relations.

In the remainder of this chapter, I outline the primary components of the NormSim framework. I have broken this discussion into three interrelated parts. I begin from the most simplistic perspective possible and slowly build in greater complexity. Of course, given the CAS foundation of the NormSim framework, even the simplistic starting point is a bit more complex than the standard IR starting point. Rather than beginning with *a priori* assumptions regarding actor interests or systemic structures, I first explain how conformity emerges within a population of heterogeneous and adaptive agents. I argue that the insights drawn from this base-level scenario can help us to understand what Young describes as local conformity in a complex system. Next, I outline the possible "lever points" of this base-level local conformity situation to explain how deviance is possible when we scale-up this scenario to understand global diversity. I focus specifically on two aspects of "social noise" and discuss their implications for norm dynamics at both the local and global level. I show how self-sustaining change is possible in a complex social structure that allows for the co-evolution of stabilizing and destabilizing forces. Finally, I explain the implications such a complex social structure has for global metastability.

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[114] Hoffmann, *Ozone depletion and climate change*, chap. 3.

3.3 Ordering Principles: Achieving Local Conformity

What are the micro-rules of behavior that lead to macro-level conformity?

There are always two opposing forces to every metastable dynamic.[115] The first is the force responsible for order and the second is the force responsible for disorder. In this section, I focus on the ordering force. I do so from the perspective of the constructivist explanation for order. In line with constructivist logic, I argue that order is an emergent property of the international system that results when a population of heterogeneous and adaptive states shares a common understanding of the world.[116] I propose a generative explanation that outlines the micro-rules of behavior responsible for this macro-level regularity. The goal of this section is to explain how international order emerges from the bottom up. This approach avoids the problem of reification common within rationalist IR theory in which theorists explain behavioral regularities from the viewpoint of an idealized homogeneous state. As Epstein's generativist motto cautions, "if you didn't grow it, you didn't explain it."[117] Thus, in order to understand the long run dynamics of international politics, I believe it is necessary to begin with an explanation of how to

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[115] Miller and Page, *Complex Adaptive Systems*, chap. 2.

[116] We see a similar understanding of order in Wendt, "Anarchy is what States Make of it."

[117] Epstein, *Generative social science*, xii.

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"grow" order in the international system. This section also satisfies the local conformity requirement of the proposed NormSim framework.

I begin this discussion with a definition of international order. I believe that order has two important dimensions in international relations and both are emergent not predetermined.[118] First, states can align on the ends they seek in the international system. I label this constitutional order. It is constitutional in the sense that such order defines which games states will play when they interact in the arena of international politics.[119] Constitutional order exists when states posses common goals of statehood. Constitutional order is necessarily an emergent property. This is because it is impossible for states to define international goals absent a "social" understanding of what it means to be a state. Statehood has both domestic and international implications for agency. On the one hand, the citizens of each state define the goals of statehood based upon domestic political objectives that require international action. On the other hand, if the state is to attain sovereign status at the international level, it is up to the international community to judge the legitimacy of varying domestic interpretations of statehood.[120] 'Illegitimate' states can certainly use force to achieve solely domestic ends but even these "asocially" defined

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[118] This is a modification of the double hermeneutic outlined in Stefano Guzzini, "A Reconstruction of Constructivism in International Relations," *European Journal of International Relations* 6, no. 2 (June 1, 2000): 147 -182.

[119] This idea stems from Wendt, "Anarchy is what States Make of it."

[120] Ian Hurd, "Legitimacy and Authority in International Politics," *International Organization* 53, no. 2 (1999): 379-408.

ends eventually meet a socially defined reality, such as when the international community

withholds sovereign status or returns force with force. It is this mutual constitution of

reality that shapes state agency and it is through ends-alignment that constitutional order

emerges within the international system. Thus, ends-alignment occurs not necessarily

because states posses the same rational materialist interests from the outset but because

states learn what it means to be a state through interactions with others.

The second dimension of international order involves the means states use to achieve

their ends. I label this prescriptive order. Alignment in this dimension results in the

classification of potential behaviors into either "appropriate" or "inappropriate"

categories.[121] This is necessary because, although states may agree on the ends they

would like to achieve in the international political arena, agreement on the means to

achieve these ends is also critical for international order. As with the definition of the

goals of statehood, states are rarely in a position to determine their means solely on an

independent basis.

The two greatest domestic barriers to international political action are the material

capabilities and political will of the state itself. However, just because a state has the will

and capacity to accomplish an international objective, states must also determine how to

achieve such goals—keeping in mind that these are open to change as well—from the

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[121] This is similar to the "logic of appropriateness" from James G. March and Johan P. Olsen, "The Institutional Dynamics of International Political Orders," *International Organization* 52, no. 4 (October 1, 1998): 943-969.

perspective of what is or is not possible in the international system. Material capabilities

can play a role in this respect but the social expectations of other states often shape state

actions more than anything else.[122] In sum, an ordered relationship is one in which both

means and ends are aligned in a given issue area. The question that remains is how does

such order emerge in an initially disorder system?

As we can see from the discussion above, order and agency are largely intertwined within

the international system. Thus, the key to an emergent explanation of order is to define

agency in a way that does not lead to a hard-wired result. This explanation for state

behavior should not stem from fixed interests or pre-programmed rules of behavior.

Order must emerge through a process of discovery in which heterogeneous adaptive

states learn how best to act in a given situation. This is how social orders develop within

a complex adaptive system.[123] In such systems, learning the rules of the game can be just

as important as playing the game itself.[124] This means that agency must include both rules

for behavior and rules for how to interpret one's world. It is these latter rules that provide

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[122] Peter L. Berger and Thomas Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*, First Thus. (Anchor, 1967); Nicholas Greenwood Onuf, *World of Our Making: Rules and Rule in Social Theory and International Relations* (Univ of South Carolina Pr, 1989); Friedrich V. Kratochwil, *Rules, norms, and decisions: on the conditions of practical and legal reasoning in international relations and domestic affairs* (Cambridge University Press, 1991).

[123] Miller and Page, *Complex Adaptive Systems*, chap. 10.

[124] This is based upon the mental models and reinforcement learning approach from John H. Holland, Keith J. Holyoak, and Richard E. Nisbett, *Induction: processes of inference, learning, and discovery* (MIT Press, 1989).

the catalyst for emergent order. After all, what we see as a stable order at the macro-level of the international system is in fact continually reproduced at the micro-level through social practices that encourage sustained means-ends alignment. Such order becomes self-reinforcing because it is the one thing that states can rely on to make consistent behavioral decisions in their dynamic social world. Thus, our understanding of the emergence of order within the international system should begin with a detailed specification of the rules states use to interpret their social environment not the rules of behavior.

The primary goal of agency in a complex social system is to maintain a reliable decision-making frame. This is made possible by the logic of consistency.[125] The logic of consistency allows adaptive agents to tune their behaviors and understandings of the world to the feedback they receive from their environment. Each experience presents a learning opportunity. Rather than calculating an optimal course of action—something that is often impossible in a complex system, adaptive social actors simply execute the behavioral option that has achieved the greatest success in the past given the situation at hand. These actors then use feedback from this experience to update their internal models of the world.[126] Feedback helps to clarify the degree to which internal models accurately portray external reality. The goal of the logic of consistency is to simply improve the

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[125] Ibid., chap. 2.

[126] For more on the internal models approach to learning, see Holland, Holyoak, and Nisbett, *Induction*.

reliability of future decision-making. Actors update their rule models by positively reinforcing information that matches reality and negatively reinforcing information that does not. Of course, one experience is not the best measure of success. Therefore, adaptive social actors only act upon information that has received the most positive reinforcement to that point in time. Reinforcement learning allows these actors to devise satisfactory behavioral responses in a complex decision-making environment without running into problems of computational intractability. At the micro-level, this approach enables "enlightened" agency but the consequences at the macro-level are just as important.

I argue that the logic of consistency is at the heart of state agency and international order. This is because states must learn to navigate the international political landscape through social interactions—cooperative or conflicting. States may approach the political arena with "pre-conceived" (domestic or historically contingent) notions of means and ends but they also use feedback to improve future decision-making.[127] States are not structural automata. They adapt to their social surroundings. Adaptation takes place within the internal rule models states use to understand their world and to determine behavior.[128] The "success" of adaptation is entirely dependent upon the state's ability to internalize a reliable representation of its complex social environment. This is extremely important to agency because rationality is essentially meaningless if there is only a weak relationship

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[127] Thompson, *Evolutionary interpretations of world politics*, chap. 1.

[128] Hoffmann, *Ozone depletion and climate change*, chap. 3.

between a state's internal picture of the world and reality. The logic of consistency provides the link between the inner environment of state decision-making and the outer environment in which decisions play out.[129] This has crucial implications for international order because the logic of consistency takes on a whole new meaning in a complex "social" system.

Decision-making in a complex social system is nearly impossible without the logic of consistency. Decision makers not only have to perform complex behavioral calculations, they also have to anticipate the countless reactions of others. This calculation can quickly lead to computational overload as the number of degrees of freedom increases exponentially—or faster. Once again, experience helps to minimize complexity. However, "social" experience adds a new twist to the logic of consistency. Each social experience imparts common feedback among the agents party to an interaction. Thus, each social experience brings the internal models of social agents closer together. Frequent interactions should result in similar internal models. A high degree of similarity across internal models should also result in systemic homogeneity and patterned behaviors. I argue that this is basically the emergent path to order that constructivists posit for the international system. However, as I outline in the next section, this is a reasonable explanation for the development of local conformity in the international system but it obviously cannot account for persistence of global diversity.

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[129] The idea for adaption between the inner and outer environment comes from Simon, *The Sciences of the Artificial - 3rd Edition*: chapt. 1.

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3.4 Disordering Principles: Enduring Global Diversity

How can we sustain global diversity when the micro-rules of behavior lead to local conformity?

In the previous section, I proposed an emergent explanation for order in the international system. The current section switches gears to focus on disordering forces. I believe this discussion is important for a number of reasons. First, although it is possible to identify areas in which states are becoming homogeneous through processes such as globalization, global diversity is still a prominent feature of the international system. Clearly the emergent explanation of order in the previous section cannot account for this diversity on its own. Second, global diversity is more than just a stylized fact about international politics. It is not something we should ignore when constructing IR frameworks. A CAS framework of IR should be just as capable of explaining disorder as it is at explaining the emergence of order. Finally, a deeper appreciation of disorder is necessary to understand the long-run trajectory of the international system. After all, diversity is the root of change. Finding a way to endogenize the mechanisms of diversity is necessary for a framework that intends to explain the self-sustaining dynamics of a complex adaptive system. I believe this is the best way to move beyond the single-shot equilibria approach of traditional IR frameworks.

The logic of consistency explains only one half of the metastable picture. It tells us how order emerges within a complex social system. The only problem with this explanation is that, once order is in place, the logic of consistency eliminates the possibility for future disorder. In other words, if state behavior was driven solely by the logic of consistency, we would expect global homogeneity to prevail in the international system, given enough time for states to interact. Of course, alignment would have to occur in every potential issue area for the system to reach full homogeneity but there is nothing in the logic of consistency to say that this would not happen eventually. In reality, the international system maintains a great deal of global diversity and it is not just a matter of time before diversity disappears. This alone may seem to invalidate the logic of consistency as a micro-level driver of state behavior. I believe such a conclusion is hastily drawn. In this section, I show that it is possible to achieve global diversity and systemic change without violating the tenets of the logic of consistency. The key to diversity and change primarily lies in the interaction structure of the system, not violations to the micro-mechanisms responsible for order.

The logic of consistency certainly overstates the case for social conformity. There is no doubt that exceptions to the rule can and do occur. Exceptions to the rule, however, are not automatically violations of the logic of consistency. It is possible for states to follow the logic of consistency in principle but for actions to fall outside the range of "expected" behaviors. This happens whenever "mistakes" in logic lead to "unexpected" behavioral outcomes. Such mistakes are often the result of "social noise." Social noise is a shorthand

way of describing how the complexity of decision-making compromises behavioral logic.

There are numerous sources of noise in every complex social system. Social noise

prevents complex social systems from settling on behavioral equilibria indefinitely. In

fact, as Thomas Schelling once argued, most systems are so noisy it is a wonder that

order emerges at all.[130] The logic of consistency helps one to filter noise so as to be able

to execute reliable behavioral decisions in a complex setting but it is not a panacea for

decision-making. Noise induces mistakes. These mistakes then provide the foundation for

future systemic change. To understand how this change unfolds, it is necessary to explain

how social noise impacts behavior within the constraints of an emergent order.

There are a number of ways to operationalize social noise to examine its impact on

emergent systemic order. Current efforts tend to emphasize the "noise" aspect of this

concept while overlooking its "social" component. For example, it is easy to use a

"scrambling" technique to replicate the effects of social noise in a simplistic manner.[131]

This method simply adds an error term—randomly drawn from a normal distribution—to

the feedback agents store in their internal models of the world. Agents then simply draw

the wrong conclusions about how to act due to misunderstandings about the world.

Joshua Epstein uses this technique in his norms model as a way to explore the impact of

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[130] Thomas C. Schelling, *Micromotives and macrobehavior* (W. W. Norton & Company, 2006).

[131] Jianzhong Wu and Robert Axelrod, "How to Cope with Noise in the Iterated Prisoner's Dilemma," *Journal of Conflict Resolution* 39, no. 1 (March 1, 1995): 183 -189.

what he terms "social turmoil."[132] To replicate social turmoil, Epstein simply shocks an ordered system with exogenous noise at some specified point in time and observes how the system responds to perturbations. This move always results in a shift to a new macro-level equilibrium or ordered pattern. Noise shocks have the effect of resetting the system to its initial disordered state. The logic of consistency then brings the system back to a new order. The new order is never the same as the old because emergent order is highly path dependent. The only way for the system to return to the previous order is for the same history of interactions to occur, which is highly unlikely in a complex social system. Although Epstein's noise shocks are rather simplistic, they do at least highlight the fact that disorder is the prerequisite to new order for agents following the logic of consistency in a complex social system.

Another way to examine the effects of social noise on decision-making is to apply a low-level exogenous shock to every behavioral decision. Epstein also employs this tactic in his model but it is a rather common procedure found in almost all models of complex adaptive systems.[133] Consistent noise is meant to emulate the ambiguity of interpreting complex social feedback or, in more general terms, to replicate bounded rationality. The idea here is that minor mistakes in rationality (consistency) occur all time. The social

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[132] Epstein, *Generative social science*, chap. 10.

[133] For examples of this use of noise, see Epstein, *Generative social science*; H. Peyton Young, "The Evolution of Conventions."; Hoffmann, *Ozone depletion and climate change*, chap. 4; Wu and Axelrod, "How to Cope with Noise in the Iterated Prisoner's Dilemma."

world is simply more complex than the simplistic internal models adaptive agents use to make reliable behavioral decisions. Again, a random error term accounts for this aspect of complexity but one that is drawn from a distribution with a lower standard deviation—this is done so that every mistake falls within "rational bounds." The introduction of consistent low-level noise typically prevents a complex adaptive system from settling indefinitely on a single behavioral equilibrium. Instead, the system tends to hover around the same equilibrium without ever settling down completely. Noise provides enough disorder to keep the system in permanent motion but it is not enough to get the system to shift to a new equilibrium over time. Such a dynamic requires coordinated mistakes and coordinated mistakes require the "social" component of social noise.

Current explanations of social noise are largely posed from the perspective of methodological individualism. Noise impacts individual decision-making and its effects are consistent throughout a population of interacting agents. However, there is more to social noise than this simple scrambling technique can capture. I believe this individualistic understanding misses the social nature and impact of noise. This is a critical oversight because socially contingent noise has important consequences for the logic of consistency and the emergence and dynamism of order in a complex social system. The logic of consistency is heavily dependent upon shared social experience. Although it is certainly true that every individual takes away a slightly different message from each interaction—misinterpreting feedback, the ability to interact with others has a much greater impact on macro-level order than individualistic noise alone. Individual

"mistakes" tend to cancel each other out unless they are coordinated in the same general direction. The only way for this to occur is for some subset of the population to receive the same consistent, but "mistaken," feedback. Where do such messages reside and how do they survive in a system driven by the logic of consistency? I believe the answer lies in the way in which individuals are exposed to information about their world.

Matthew Hoffmann,[134] following the lead of Martha Finnemore and Kathryn Sikkink,[135] offers a partial solution to the logic of consistency paradox. His solution uses norm entrepreneurs to explain how complex social systems achieve a metastable dynamic. Hoffmann's norm entrepreneurship is similar in style to a noise shock. However, rather than scrambling an individual's understanding of the world, norm entrepreneurs offer the entire population of agents a single consistent message that is different than the message each is likely to receive through social feedback given the current order (or lack thereof) of the system. In other words, norm entrepreneurs provide consistent "mistaken" feedback necessary to tip the system towards a new order—the order of the entrepreneur's suggestion. Of course, norm entrepreneurs are not all powerful. The success of entrepreneurship is entirely dependent upon the stability of the current order. A consistent but "mistaken" message will only work if there are pockets of instability for the message to take hold. Individuals who have been exposed to inconsistent feedback due to the presence of noise are the ones who are likely to act upon the entrepreneur's

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[134] Hoffmann, *Ozone depletion and climate change*, chap. 4.

[135] Finnemore and Sikkink, "International Norm Dynamics and Political Change."

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suggestion. These individuals then echo the entrepreneur's message in future interactions with others. This echoing causes others to reassess their own internal models. Given the right amount of noise and the development of a critical mass of followers, the entrepreneur's suggestion eventually takes hold and becomes the new self-reinforcing order of the system. Hoffmann's solution is important because it shows that coordinated mistakes can lead to changes in systemic order. Nevertheless, I believe it is only a partial solution to the logic of consistency paradox because it leaves entrepreneurship itself unexplained.

The major limitation of the norm entrepreneurship solution is that it contradicts the explanation of emergent order. Norm entrepreneurship violates the tenets of the logic of consistency. Entrepreneurial change requires an opposing behavioral logic—the logic of stubbornness. The logic of consistency cannot explain why entrepreneurs are immune to social feedback, why they commit to rival understandings of the world, or where the source of such discrepancies reside. Cast in this light, norm entrepreneurship is a deterministic not emergent phenomenon. More importantly, such an explanation of change is both theoretically inconsistent and limited in its ability to account for key dynamics. It is possible, however, to reinterpret the insights of entrepreneurship while maintaining theoretical consistency. To do this, it is necessary to reframe critical aspects of entrepreneurship from the perspective of the logic of consistency and complex social relations. I argue that a more nuanced understanding of critical mass is fundamental to an endogenous explanation of entrepreneurship and change.

Every order in a complex social system resides in a critical mass.[136] Order emerges when a critical mass internalizes a common understanding of the world. New orders emerge when the critical mass shifts to a new understanding. In this way, order is equivalent to the existence of a critical mass. The logic of consistency explains how such order emerges through social interaction. The key to emergence is shared experience but it is not necessary for every individual to share the same experience concurrently. A critical mass can develop through social diffusion. In fact, this is how norm entrepreneurship generates change. Norm entrepreneurs plant the seed for change and their followers diffuse this message throughout the rest of the population. This process of indirect socialization highlights an important point about social complexity and one that explanations of emergent order often overlook. The emergence and social impact of a critical mass hinges on the underlying interaction structure of the system. In complex social systems, emergent order is the result of indirect socialization and, thus, it should be possible to account for the source of dynamism within these structures as well.

It is easy to demonstrate the importance of the underlying interaction structure of a system using a few idealized examples. Two structures have relatively obvious implications. The first is a structure in which no interaction takes place among individual agents. In this extremely simplistic scenario, agents must adjust their internal models of the world without social feedback. Order is only possible in this scenario if all agents

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[136] Ibid.

begin life with the same understanding of the world and they assume no information

confirms their beliefs or they randomly align on the same understanding accidentally.

The alternative scenario, which is the best scenario to confirm the theoretical coherence

of the logic of consistency, is to assume a global interaction scheme. In this scenario,

either every individual accesses global social feedback or they have an equal chance of

interacting with others in the system over time. As long as internal mistakes in logic are

kept to a minimum, the long run trajectory of such a system is global homogeneity.

Clearly both interaction schemes—and their resulting emergent orders—are implausible

from the perspective of a complex social system but they also do not exhaust the list of

potential alternatives.

One way to achieve two out of the three characteristics of a complex adaptive system—

local conformity and global diversity—with a relatively simple interaction scheme is to

use a local interaction structure. In this scenario, interactions take place only with locally

circumscribed bounds. This local structure is a convenient way to explore the effects of

independent and isolated interactions. In terms of the international system, a local

interaction structure provides a bit more realism because, at least historically, interactions

between neighboring states often dominate the system. This is an effect that has had an

important impact on the emergence of orders in areas such as the security domain (see

figure 1).[137] This is because the act of bounding social relations in an organized manner

[137] Barry Buzan and Ole Wæver, *Regions and powers: the structure of international security* (Cambridge University Press, 2003).

allows for unbalanced interactions. Unbalanced interactions and indirect socialization

leads to the emergence of multiple critical masses within the same social system. As

mentioned above, this outcome achieves two out of the three characteristic features of a

complex adaptive system. The only thing missing is the existence of punctuated

equilibria. The local interaction structure provides a single-shot explanation for emergent

complexity but it is possible to rework this solution to achieve self-sustaining dynamism

with only a minor modification.

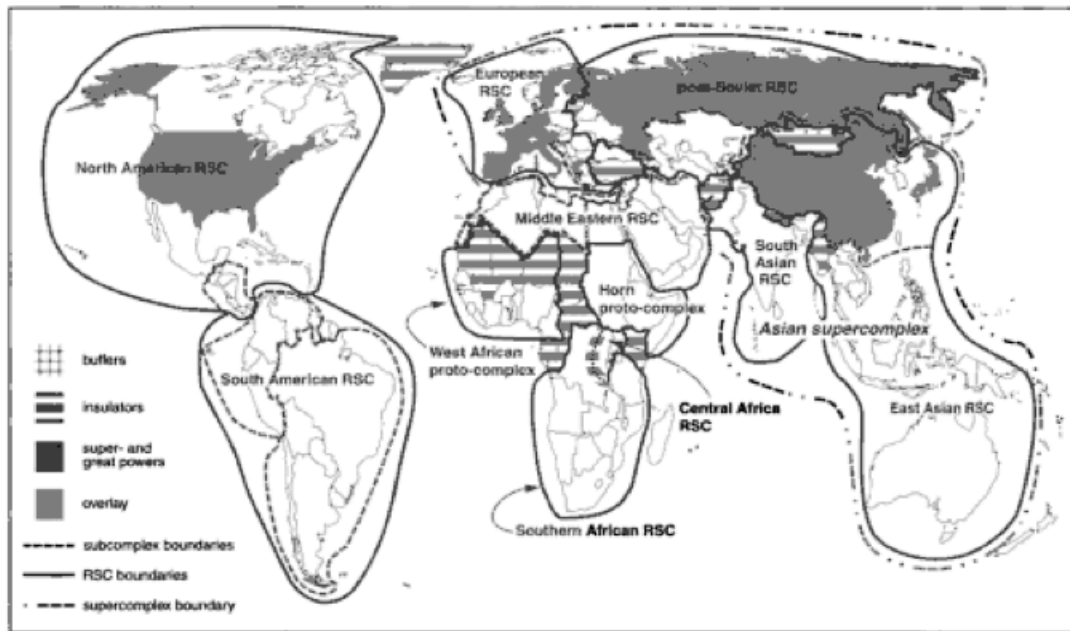Figure 1. Regional Order. Regional security communities after the Cold War, from Buzan and Waever's *Regions and Powers: The Structure of International Security*. This illustration provides one way to conceptualize the regional or spatial interaction structure of security within the international system. This is the absolute minimum level of social complexity that is necessary to generate local conformity and global diversity.

3.4 Ordering Disorder: Social Complexity and Punctuated Equilibria

How does social complexity generate metastability?

Local proximity is one way to define an interaction structure but most social systems are much more complex than this. For example, figure 2 depicts just some of the major socio-political interaction possibilities of the international system. In this figure, we can see that the international system is much more socially complex than the local interaction structure of the previous section. This is because the international system is composed of a wide range of political actors and each circumscribes its own set of independent or overlapping socio-political relations. Individuals are the basic social unit of this system but it also includes a number of important aggregate social actors. The state has long served as the main aggregate political unit above the individual acting on behalf of the interests of its citizens in the arena of international politics since the Peace of Westphalia.[138] However, non-state actors also play a prominent role in today's global political landscape.[139] These actors include both intergovernmental organizations (IGOs) that act on behalf of the collective interests of states (e.g. the European Union) and non-governmental organizations (NGOs) that act on behalf of collective individual interests

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[138] Waltz, *Theory of International Politics*.

[139] Michael N. Barnett and Raymond Duvall, *Power in global governance* (Cambridge University Press, 2005); David Held and Anthony G. McGrew, *Governing globalization: power, authority and global governance* (Wiley-Blackwell, 2002); Rorden Wilkinson and Stephen Hughes, *Global governance: critical perspectives* (Psychology Press, 2002).

detached from territorially bound political authority (e.g. Amnesty International). It is

within this socially complex system that states must adapt to feedback from others and it

is this same social complexity that is responsible for the punctuated equilibria of
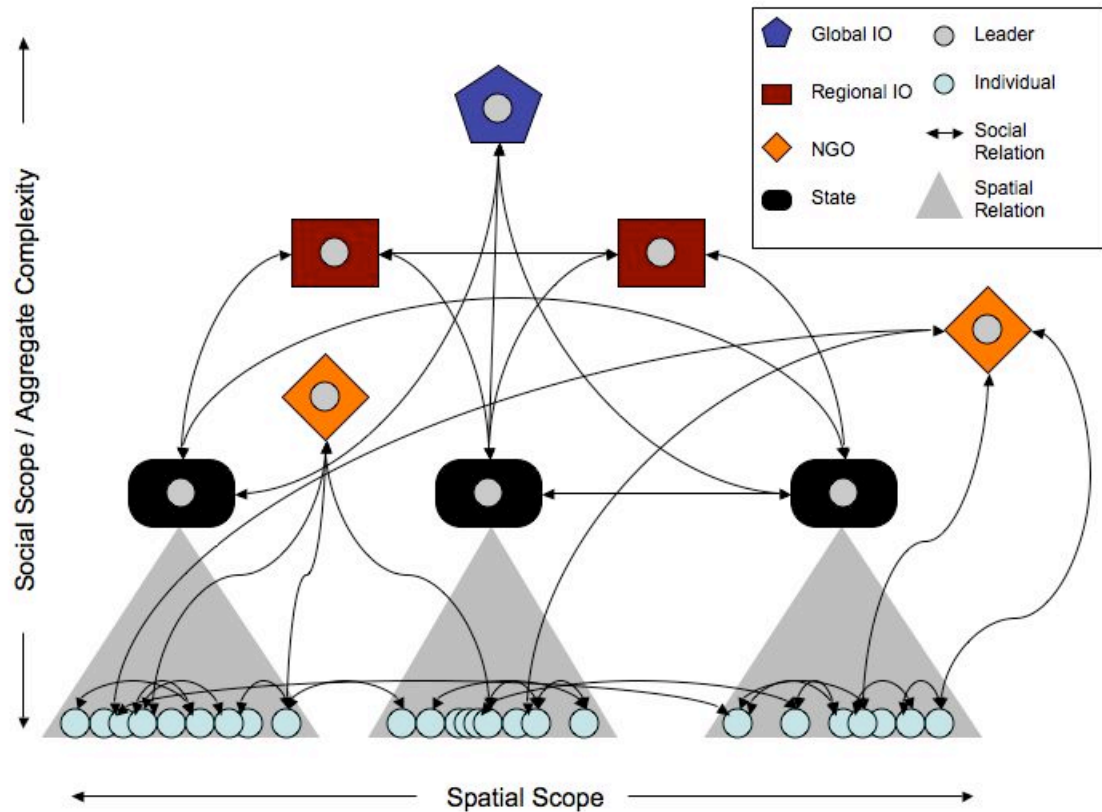
international normative order.

Figure 2. International Social Complexity. The above diagram represents some of the major interaction possibilities of the international system. The x-axis represents the spatial configuration of the system and the y-axis represents the social or political complexity dimension of the system. Each shape represents either an individual actor or an aggregate political actor representing a group of individuals such as a state (e.g. France, Great Britain, Germany, etc.), regional international organization (e.g. the European Union), non-governmental organization (e.g. Amnesty International), or a global organization (e.g. the United Nations).

The social complexity of the international system plays a key role in shaping the emergence and dynamism of normative order. One of its most important features is that it enables the emergence of stable, localized norm communities. This is because the international system is a nearly decomposable system in which interactions at the subsystem level are much more frequent than interactions at the systemic level.[140] The state is one example of a sub-systemic component that makes such interaction possible in the international system. States are crucial to the emergence and sustainability of international normative order because they supply stable aggregate input into the global intersubjective context. Without the state, the global intersubjective context would be much more chaotic and difficult to interpret as it would include many more and potentially conflicting messages. The state itself achieves intersubjective stability in two ways. First, the state possesses clearly circumscribed socio-political borders. Second, it is able to reduce its own internal intersubjective context into a single message using an organized political hierarchy. Of course, the consistency of this message is open to internal dynamics—such as when states change their position on foreign policy due to regime change—but, in the short run, the state is a relatively stable and consistent socio-political actor. Thus, the state frequently serves as the primary social subcomponent through which global normative orders emerge.

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[140] For more on the effects of a nearly decomposable system, see Simon, *The Sciences of the Artificial - 3rd Edition*, chap. 9.

Of course, beyond the state, the international system lacks a political hierarchy—with the important exception of the EU in certain policy domains. Therefore, in order for norms to emerge and remain sustainable above the state, a critical mass of states must adopt the same interpretation of the global intersubjective message. We know from nearly decomposable systems that this is much more likely to occur at the subcomponent level than at the global systemic level because subsystem order is much more stable and easier to establish than systemic order.[141] There are a number of potential subsystems that exist above the state that could fulfill the same social circumscription role the state plays at the domestic level.[142] Possible candidates include the many IGOs and NGOs that enable alternative global socio-political interactions in the international political arena. Of these two, IGOs are likely to lead to more stable and complex international normative orders than NGOs simply because IGOs can take advantage of the subcomponent stability of their member states. Furthermore, regional IGOs—such as the EU—are also more likely to establish stable orders in most policies areas due to the greater likelihood of shared experience within a region and higher levels of intra-regional interactions. The crucial

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[141] This idea for sub-systemic stability is discussed in the following works: Buzan and Wæver, *Regions and powers*; Barry Buzan, Charles A. Jones, and Richard Little, *The logic of anarchy: neorealism to structural realism* (Columbia University Press, 1993).

[142] This idea for social circumscription is adopted from Robert L. Carneiro, "A Theory of the Origin of the State," *Science* 169, no. 3947, New Series (1970): 733-738.

feature of these interaction structures is that they partition the global intersubjective context to achieve stable sub-systemic order at the level of the state.[143]

Regional IGOs can help to stabilize complex global normative orders but they cannot achieve the same level of stability as the state because they often lack a political hierarchy and their social circumscription boundaries are much more permeable than states. Of course, some regions achieve social circumscription better than others. The EU is again a prime example of this. The EU has clear social circumscription borders—signified by its member state status—and intra-EU interactions occur at a much higher rate than inter-EU interactions in almost all issue areas. The one important exception to this is in the realm of international security where significant overlap exists between the EU and NATO, as one example. Such overlap highlights the fact that regional IGOs lie closer to the fully decomposable end of the spectrum than the state, which is almost entirely nearly decomposable. This means that regional orders are more open to destabilizing forces than state orders because regional orders are often exposed to more conflicting interpretations of appropriateness and they lack the hierarchical means to filter this feedback into a single stable intersubjective message. Thus, regional IGOs possess two key characteristics necessary for metastable order.

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[143] This idea of a partitioned interaction structure is presented in the fields concept adopted from Pierre Bordieu, see GUZZINI, "A Reconstruction of Constructivism in International Relations."

First, regional IGOs allow for the emergence of stable localized norm communities. This is important for subsystem stability and the establishment of complex orders above the state. The regional IGOs' ability to socially circumscribe and stabilize a complex intersubjective message is a crucial ordering factor for global metastability. Second, regional IGOs also face a number of disordering forces. These forces can explain why many international orders built upon sub-systemic order are metastable not fixed. Disorder occurs when the member states of regional IGOs are exposed to competing interpretations of appropriateness. This can happen in a number of ways. Examples include: unique extra-regional experiences (e.g. EU member state relations with former colonies), domestic change leading to changes in foreign policy (e.g. a new party securing power or a terrorist event sparking policy reform), and overlapping interactions spheres (e.g. EU member states who belong to NATO). What is important about these disordering experiences is that they transmit social feedback which conflicts with the current regional order. In other words, they are crucial sources of "social noise."

The extent to which social noise disrupts regional order is dependent upon its ability to foster a critical mass that can compete with the current regional interpretation of appropriateness. This is much more likely to occur when multiple state are exposed to the same conflicting message rather than through unique exogenous or endogenous events alone. This is because isolated instability fails to achieve the same social momentum of collective instability that enables conflicting intersubjective messages to diffuse throughout the regional subsystem. Such collective instability is likely to occur within the

space in which two or more social interaction spheres overlap (see figure 3). Those

within these overlapping social spaces are the ones most exposed to conflicting

intersubjective messages and it is their response to instability that determines which way

the regional order is likely to tip. Thus, the degree to which localized orders overlap

within the international system can have a major impact on the metastable character of

normative order. It is within this overlap that we would expect instability to occur and

such instability is expected to serve as the impetus for the emergence of new regional
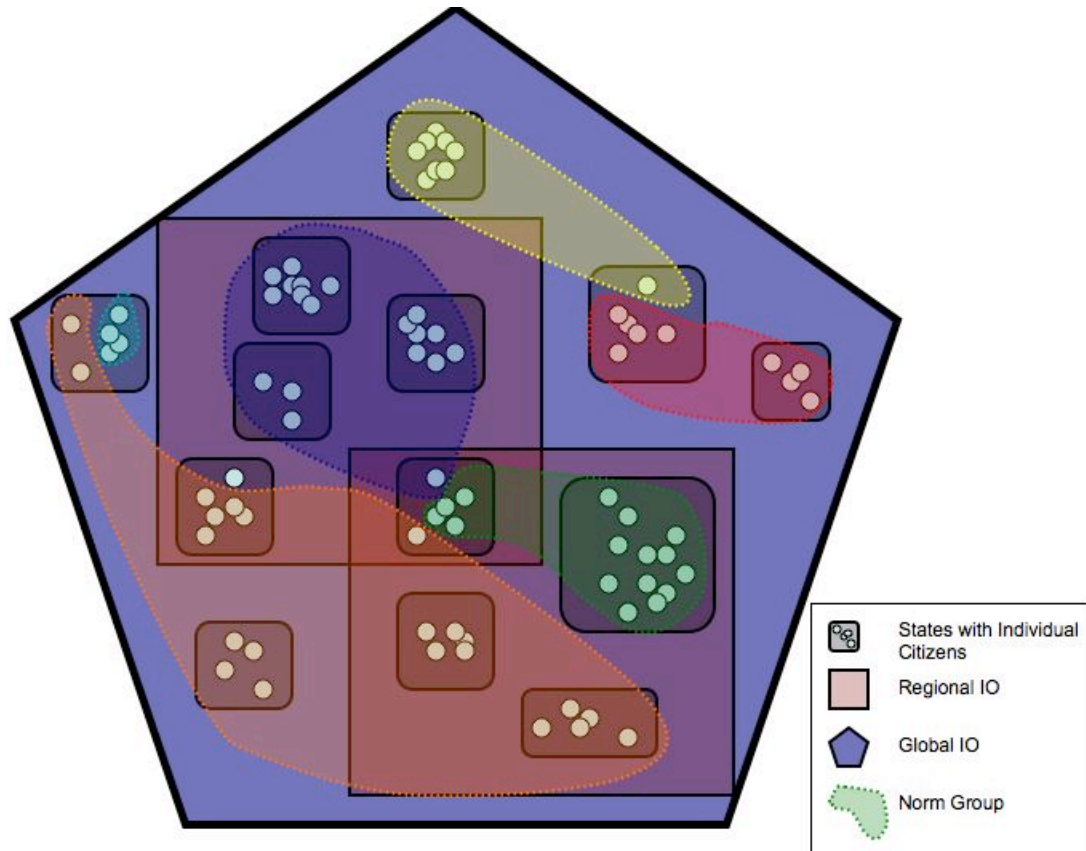
orders.

Figure 3. Social Circumscription in the International System. The above diagram shows where conflicting social feedback is likely to develop within a complex social system such as the international system. The state at the center of this diagram is circumscribed within two competing interpretations of appropriateness. An empirical example of such a situation would be the position of Great Britain in the security realm. Great Britain is a member of both the EU and NATO. Both have had a role in the socialization of British security behavior. The Iraq War was an example of how the British found themselves caught between an EU and NATO interpretation of appropriateness regarding the justification for intervention in Iraq.

The dynamic process that leads to the establishment of new regional order resembles the

non-deterministic phase transitions of Claudio Cioffi-Revilla's canonical theory of social

complexity.[144] We can apply this branching process to the general framework of Finnemore and Sikkink's Norm Life Cycle[145] to understand how socially circumscribed orders evolve over time (see figure 4). Figure 4 outlines the primary phase transitions a new interpretation of appropriateness must undergo to replace the current socially circumscribed order. Each phase marks a critical breaking point in which the social momentum of noise either advances or dissolves. The process begins with a stable regional order. In the first phase, states are exposed to conflicting social feedback through either an exogenous or an endogenous event, as described above. Border instability occurs whenever this conflicting social feedback is consistently reinforced from a stable social context outside the region. Without this reinforcement, the logic of consistency would re-stabilize the current regional order. In the second phase, border instability provides an opportunity for a new interpretation of appropriateness to gain a foothold within the region. This occurs only if a critical mass of states is exposed to the same conflicting message. This new competing critical mass induces further norm slippage within the region as more states become exposed to conflicting social feedback. In the final phase, the new competing critical mass within the region either leads to the diffusion of instability throughout the community and the emergence of a new regional order or produces regional social gridlock. Without further reinforcement or diffusion of the new interpretation of appropriateness, the logic of consistency should return the

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[144] Cioffi-Revilla, "A Canonical Theory of Origins and Development of Social Complexity."

[145] Finnemore and Sikkink, "International Norm Dynamics and Political Change."

region back to the previous order—this may require a period of sustained social gridlock
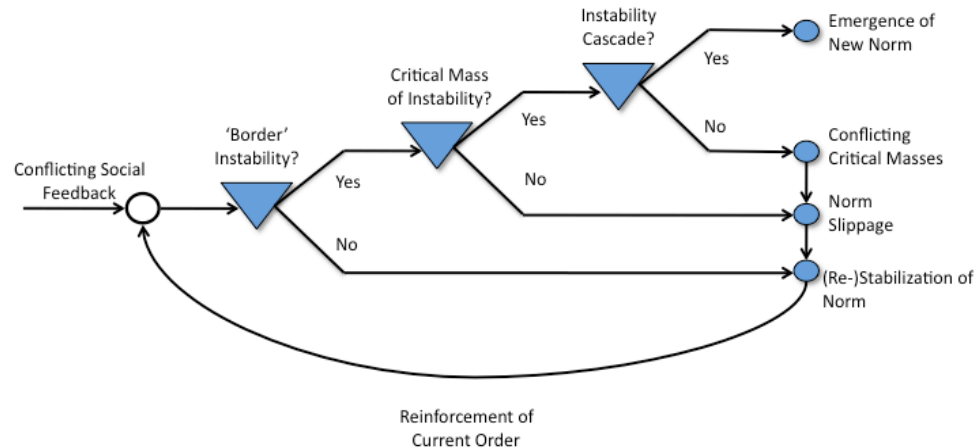
before the previous order is restored.

Figure 4. Instability Diffusion. The emergence of new socially circumscribed norms is expected to follow the above non-deterministic "fast" branching process. Each phase of this process represents a potential opportunity for conflicting social feedback to lead to new normative order. The "slow" process integrates over many passes through this fast canonical process to generate order.

The above discussion leads to the following assumptions regarding the emergence and

evolution of normative orders in the international system:

1) The logic of consistency should lead to global homogeneity when all actors

   have a chance to consistently access the same intersubjective message.

2) The logic of consistency can produce local conformity and global diversity if

   actors consistently access a socially circumscribed intersubjective message.

3) The logic of consistency can produce local conformity, global diversity, and

   punctuated equilibria if actors consistently access a socially circumscribed

   intersubjective message but such social circumscription also permits overlap.

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a. If social overlap exists, those on the social borders are likely to experience instability.

b. If collective instability occurs on the social border, this is likely to induce further instability within the region.

c. If instability diffuses throughout the region, it is possible for a new order to emerge from this disorder.

3.6 Conclusion

The current chapter describes the NormSim framework. NormSim builds upon basic constructivist logic to explain how normative orders emerge and evolve in the international system. The goal of NormSim is to replicate the three defining characteristics of complex adaptive systems from the perspective of international relations: local conformity, global diversity, and punctuated equilibria. In the first section, I explain why basic constructivist logic fails to account for these features of complexity. I show that the adaptive logic of constructivism leads to global homogeneity in a simplistic social context where every actor has access to the same intersubjective message. Thus, we can use basic constructivist logic to understand how norms emerge but it overlooks the dynamics responsible for norm evolution. In the second section, I argue that a more nuanced understanding of the constructivist intersubjective context can explain the first two features of a complex adaptive system: local conformity and global diversity. A simple local interaction structure enables the social circumscription

necessary to generate competing interpretations of appropriateness within the same social system. In the final section, I explain how social circumscription leads to metastable orders when competing critical masses overlap. I also outline where in a complex social system this is likely to occur and how this evolutionary process unfolds over time.

The NormSim framework provides an endogenous explanation for the metastable dynamics of normative order. It identifies the ordering and disordering forces needed to generate changes in norms over time. This makes it possible to understand some of the more complex emergent dynamics of norms beyond the conformity dimension. We can use this framework to investigate problems that standard constructivist logic fails to explain or overlooks entirely. For example, the basic constructivist understanding of the EU case, presented in the first chapter, would lead to a single-shot and simplistic conformity explanation. Our focus would center on the ordering forces of conformity. This would lead us to overlook the disordering forces responsible for internal instability. In this way, we could not explain major events like the internal division within the EU over the Iraq War. We would have to accept these events as either violations to constructivist logic or minor aberrations on the path towards conformity. Either way, we would lose a great deal of explanatory power in the process. I argue that such events fit within the NormSim framework and understanding the dynamics of these events is critical to understanding how the EU is likely to evolve beyond the Iraq War. However, to gain this insight, it is necessary to ensure the logical consistency of the claims outlined

in this chapter. That is why I now turn to a formal analysis of the NormSim framework in

the next two chapters of this study.

4. NORMSIM IN MASON

4.1 Introduction

I have shown in the previous two chapters how the field of International Relations (IR)

oversimplifies the complex dynamics of the international system. The problem occurs

when researchers view the international system through a static equilibrium lens. Such an

approach results in explanations of the whole as a sum of its parts.[146] This criticism is

well documented for the rational materialist theories of neorealism and neoliberalism

whose firm reliance on methodological individualism leads to an inability to account for

long run systemic change.[147] The same criticism also applies to social constructivist

frameworks, despite claims that constructivism provides a dynamic and intersubjectively

posed alternative to rational materialism.[148] However, the problem for constructivism is

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[146] Epstein, *Generative social science*, chap. 3; Miller and Page, *Complex Adaptive Systems*, chap. 2; Scott Moss and Bruce Edmonds, "Towards Good Social Science," October 31, 2005, http://jasss.soc.surrey.ac.uk/8/4/13.html.

[147] Adler, "Seizing the Middle Ground."; Cederman, *Emergent actors in world politics*; Collard-Wexler, "Integration Under Anarchy."; Finnemore and Sikkink, "International Norm Dynamics and Political Change."; Hopf, "The Promise of Constructivism in International Relations Theory."; Alex Inkeles, "The Emerging Social Structure of the World," *World Politics* 27, no. 4 (July 1, 1975): 467-495; Wendt, *Social Theory of International Politics (Cambridge Studies in International Relations)*.

[148] Checkel, "Review."; Hoffmann, *Ozone depletion and climate change*, chap. 3.

often more of method than of theory. Constructivism seems to possess all (or most) of the theoretical pieces of the complex and dynamic puzzle of international relations but lacks an appropriate methodological approach to validate its claims. I argue in the current chapter that it is necessary to validate constructivist assumptions in an Agent-Based Model (ABM) to fully grasp the theoretical importance of this paradigm.

The following chapter unfolds in three parts. First, I describe the ABM approach. I outline the methodological advantages of ABM for our ability to understand the evolving dynamics of complex adaptive systems. I also explain how ABM compares to alternative modeling approaches such those of game theory and equation-based modeling. Next, I make the case for the use of ABM in the realm of IR. I compare the traditional methodological approaches of IR theory to ABM. I argue that ABM solves the inductive-deductive problem through its ability to serve as a "third way of doing science."[149] ABM provides the opportunity to formally test theoretical assumptions in a way that overcomes the limitations of process tracing analysis. ABM also is able to do this without requiring theories to filter out the complexities of real-world systems necessary for understanding long run change. Finally, I conclude this chapter with a description of the NormSim model. I discuss the primary features of NormSim and explain how to use NormSim to test the theoretical claims proposed in the previous chapter. I conduct this formal analysis and describe the simulation results in the following chapter.

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[149] Rosaria Conte, Rainer Hegselmann, and Pietro Terna, *Simulating Social Phenomena*, 1st ed. (Springer, 1997), 25.

4.2 Agent-Based Methodology: A Toolkit for Bottom-Up Research

International relations research shares many of the same theoretical and methodological problems as its counterparts in the social sciences. On the theoretical side, researchers must decide which features of a complex social system are fundamental to the problem at hand and which can be reasonably ignored.[150] This is an extremely challenging task. Clearly the model that achieves the most explanatory power with the least complexity is preferable in theory but not always possible in practice. I have shown in the previous chapter that attempts to achieve parsimonious explanations have led to a number of important theoretical limitations for our understanding of the international system. This is because, despite the need for parsimony, all social problems are inherently complex, dynamic, and difficult to explain from a simplistic perspective. The basic simplifying assumptions for formal modeling—linearity, methodological individualism, and static equilibrium attainment—fail to capture the mechanisms necessary to explain emergent and evolving phenomena.[151] This does not discount the importance of formalization or parsimony. It simply requires researchers to achieve formal parsimonious explanations in a non-traditional manner. In this section, I explain how Agent Based Modeling can help

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[150] The standard approach to this problem in International Relations research is presented in King, Keohane, and Verba, *Designing social inquiry*.

[151] See Axelrod, Robert, in Conte, Hegselmann, and Terna, *Simulating Social Phenomena*; Epstein, Axtell, and Project, *Growing artificial societies*, chap. 1; Miller and Page, *Complex Adaptive Systems*, chap. 5.

to overcome the drawbacks of traditional IR methods. I argue that much of this discussion mirrors the ongoing debate between constructivism and rational materialism.

As detailed in the previous chapter, much of constructivism's success in the field of IR can be attributed to its cogent criticism of rational materialism. Neorealist and neoliberal efforts to apply the rational actor paradigm to interstate relations have largely been the target of this criticism. Constructivists claim that rationalism (in its materialist form) leads to a misguided and oversimplified understanding of the importance of self-interest, material gain, and state survival. Such oversimplifications make it impossible to explain the nuance and dynamism of international politics.[152] Ironically, this is exactly why neorealists and neoliberals adopted the rational actor paradigm in the first place. They were hoping to overcome the loose positivism of reductionist theories, which were then prominent in IR.[153] Neorealists and neoliberals believed the rational actor paradigm could achieve the same positivist agenda of neoclassical economics. The primary motivation was the construction of falsifiable theories and theoretical assumptions. The rational actor paradigm appeared to offer this solution.[154] At the very least, it was significantly more positivist than the alternative prose approach.[155] Rational materialists believed they were

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[152] Rosenau, *Turbulence in world politics*.

[153] This idea has its roots in Waltz, *Theory of International Politics*, chap. 2-4.

[154] Jon Elster, "The Case for Methodological Individualism," *Theory and Society* 11, no. 4 (July 1, 1982): 453-482; Gintis, *The Bounds of Reason*.

[155] A comparison of the two approaches is offered in Miller and Page, *Complex Adaptive Systems*, chap. 5.

gaining more than they sacrificed by choosing formalism over qualitative description. Thus, to understand how ABM could enhance IR theory, it is first necessary to explain how it addresses the methodological rift between constructivism and rational materialism.

The rift between constructivism and rational materialism is theoretical on the surface but, if we delve into the specific claims of either side, we can see that much of this debate has methodological origins. This is so because one of the major difficulties of IR research—or social science research in general—is the ability to validate one's theoretical assumptions. The methodological tools available to confirm hypotheses severely limit theoretical possibilities.[156] Of course, depending upon whether a given theory takes a positivist or post-positivist stance, some limitations are more important than others. The positivist approach of rational materialism is much more limiting than the post-positivist approach of constructivism. This impacts both the methodological tools one is willing to use to test claims as well as the ways in which both use common tools.[157] For example, rational materialism is much more open to the use of formal methods than constructivism. The formalization requirements of game theory, equation-based modeling, and statistical analysis fit nicely with the theoretical and epistemological underpinnings of neorealism and neoliberalism. Formal methods begin with a detailed specification of theoretical claims; they proceed to confirm claims through deductive reasoning; and the

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[156] Hoffmann, *Ozone depletion and climate change*, chap. 4.

[157] Audie Klotz and Cecelia Lynch, *Strategies for research in constructivist international relations* (M.E. Sharpe, 2007).

confirmation of claims is assumed to be objectively valid. The standard formal approach

produces precise and analytically rigorous conclusions. This is critical for positivist

theory but it does not guarantee empirical validity.[158] At the very least, conclusions

drawn from formal analysis are highly constrained to the specific circumstances in which

such claims are expected to hold.[159] However, as constructivists have shown, these

circumstances are rarely static features of the international system.[160] Thus,

constructivists and rational materialists cannot avoid the problem of having to justify

their claims using the more flexible but potentially ambiguous qualitative description

approach.

Constructivists and rational materialists both use qualitative description to empirically

validate theoretical claims but both have slightly different interpretations of what

qualifies as validation. In this case, the constructivist toolkit is much broader than the

rational materialist. The methodological flexibility of qualitative description enables

constructivists to test theoretical claims from a post-positivist perspective. Constructivists

take advantage of this flexibility to explore the consequences of intersubjective factors,

such as the role of norms and identities on state behavior. They also use techniques such

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[158] Epstein, *Generative social science*, chap. 3.

[159] Miller and Page, *Complex Adaptive Systems*, chap. 5.

[160] Wendt, "Constructing International Politics."

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as process tracing to validate complex, dynamic, and path dependent claims.[161] Much of

this work would be difficult—if not impossible—to conduct using traditional formal

methods. The intangibles of constructivism do not translate well into the formal

requirements necessary for game theory, mathematical modeling, or statistical analysis.

This also makes it harder to deductively verify constructivist claims, which is not

something qualitative description can help a theory to overcome.[162] Constructivists

successfully use qualitative description to falsify the objective claims of rational

materialism but it is much more difficult for constructivists to offer their own falsifiable

assumptions absent the analytical rigor of rival theories that allows for such criticism.[163]

The complex, non-linear, and interpretavist assumptions of constructivism incur greater

validation penalties due to the analytical flexibility of qualitative description.

Constructivists who rely on qualitative description alone to validate theoretical claims

find themselves in a somewhat difficult position. In order to relax the precision of

rational materialism, it is sometimes necessary to give up on falsification. For

constructivists with critical theory leanings, this is not a problem. For those who value the

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[161] Finnemore, *National interests in international society*; Checkel, "Why Comply?";
Klotz and Lynch, *Strategies for research in constructivist international relations*.

[162] Miller and Page, *Complex Adaptive Systems*, chap. 5.

[163] Checkel, "Review"; Moravcsik, " 'Is something rotten in the state of Denmark?".

positivist side of post-positivism, this is a less attractive option.[164] It is this latter group of

constructivists that could benefit the most from ABM.

ABM is a computer simulation technique used to replicate and understand complex

emergent phenomenon.[165] The simulation itself consists of a set of heterogeneous

autonomous agents that act upon simple rules of behavior to interact with other agents

and their environment. The goal is to identify the micro-level conditions (agent and

environmental characteristics) necessary for macro-level patterns to emerge through

agent interactions.[166] The simulations themselves show which complex macro-level

patterns are possible given an initial simplistic set of micro-level specifications. This is

crucial for a generativist explanation of complexity because it allows modelers to

formally track and analyze bottom-up processes rather than having to devise top-down

solutions to achieve analytical tractability.[167] ABM is also flexible in that it is possible to

tailor both the agents and the agent-environment to meet a wide range of behavioral and

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[164] For a review of the differences between the two approaches to constructivism, see
Adler, Emanuel, "Constructivism and International Relations" in Carlsnaes, Risse, and
Simmons, *Handbook of international relations*, chap. 5.

[165] For a general overview of this approach, see G. Nigel Gilbert, *Agent-based models*
(SAGE, 2008).

[166] This bottom-up approach to research is described in Epstein, Axtell, and Project,
Growing artificial societies.

[167] Epstein, *Generative social science*, chap. 1-3; Epstein, Axtell, and Project, *Growing
artificial societies*, chap. 1.

interactive demands.[168] The simplistic agents of cellular automata simply respond to their

environment and other agents in a deterministic manner whereas the advanced agents of

more complex models both manipulate and adapt to their environment and other agents.

ABM simulations can also represent a wide range of complex adaptive systems, from ant

colonies[169] to interstate relations,[170] using the same methodological toolkit. More

importantly, modelers can experimentally control each simulation so as to analyze the

implications of various changes in model parameters, allowing one to rerun the tape of

history to test "what if" scenarios.[171] This combination of formalism and flexibility is

invaluable for complexity studies in general and constructivism specifically.[172]

ABM fills an important methodological niche between formal methods and qualitative

description. As I have mentioned above, Robert Axelrod has described ABM as a "third

way" of doing science. This is because ABM permits precision without highly

constrained solutions and flexibility without the need to abandon falsifiable claims. The

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[168] Claudio Cioffi-Revilla, "A Methodology for Complex Social Simulations,"
Text.Article, January 31, 2010, http://jasss.soc.surrey.ac.uk/13/1/7.html; Conte,
Hegselmann, and Terna, *Simulating Social Phenomena*; Nigel Gilbert and Klaus
Troitzsch, *Simulation for the Social Scientist*, 2nd ed. (Open University Press, 2005),
chap. 8.

[169] Mesude Bicak, "Agent-Based Modelling of Decentralized Ant Behaviour using High
Performance Computing," Thesis, January 28, 2011, http://etheses.whiterose.ac.uk/1392/.

[170] Cederman, *Emergent actors in world politics*.

[171] Epstein, Axtell, and Project, *Growing artificial societies*.

[172] Hoffmann, *Ozone depletion and climate change*, chap. 4.

ABM method has become widely adopted throughout the natural and social sciences for this very reason. Researchers from the diverse fields of biology, artificial intelligence, economics, anthropology, ecology, and political science (to name a few) use ABM simulation to explore similar emergent phenomena. Their shared goal is to understand how complex adaptive systems produce macro-level regularities and to understand how such patterns evolve over time. I have argued in the previous chapters that this is very much the same goal constructivist attempt to achieve in IR. Regardless of the discipline, traditional methods make it difficult to achieve this goal for two reasons. First, formal analytical methods are simply too restrictive to allow for generative explanations of emergent phenomena.[173] On the other hand, qualitative description lacks the analytical rigor necessary to confirm that one's proposed generative explanation is more appropriate than the multitude of potential generative explanations that may account for the same emergent pattern.[174] ABM provides the solution to both of these issues in a single methodological approach. The advantages of ABM for constructivist research can be seen both in how it relaxes the strict assumptions of formal modeling and in how it enables formal analysis of traditional qualitative phenomena. In other words, ABM is both an appropriate formal analysis tool for constructivist research and constructivism itself could gain a great deal of validation credibility by adopting this approach.

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[173] Miller and Page, *Complex Adaptive Systems*, chap. 5.

[174] Epstein, *Generative social science*, chap. 1-3.

There are five reasons why it is better to use ABM for a formal analysis of the international system rather than traditional methods. Each reason mirrors a common constructivist critique of rational materialism. For example, the first advantage of ABM is its bottom-up approach to analysis. ABM is distinct in its ability to avoid the top-down model fitting of analytical methods. Methods such as game theory require tightly imposed and exogenously defined restraints on actor behavior. This makes it possible to devise equilibrium solutions to complex interaction problems but often results in oversimplified understandings of empirical phenomena. ABM is much less restrictive and much more endogenous.[175] Although ABM agents share a basic behavioral strategy and interact in a common environment, each agent maintains a high degree of autonomy throughout the simulation—as with the international system, there is no central control. Therefore, the results of every simulation are a product of a unique history of independent interactions, not analytical solutions to problems meeting pre-defined and empirically questionable constraints. The process-oriented approach of ABM is crucial to the study of emergent and complex phenomena because it allows path-dependencies and non-linear dynamics to unfold. Constructivists make a similar process-oriented argument about the study of international norms when criticizing rational materialism's *a priori* understanding of state behavior, claiming anarchy is what states make of it.[176] A generativist explanation of the international system clearly requires a method that can explore the unintended consequences of limited agency and the dynamic long run

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[175] Miller and Page, *Complex Adaptive Systems*, chap. 6.

[176] Wendt, "Anarchy is what States Make of it."

trajectories of "messy systems."[177] The top-down approach of formal analytical modeling

misses this dynamism altogether, as do the rational materialists who adopt this approach

to validate their theoretical claims.

The second advantage of ABM is that it allows researchers to examine the independent

interactive effects of heterogeneous actors.[178] In this way, ABM provides a formal

solution to overcome what rational materialists consider the limitation of reductionist

theory—using the varied individual (subjective) characteristics of states to explain

international behaviors. The concern is that reductionist assumptions are impossible to

validate analytically and difficult to falsify empirically. The formal analytical solution to

this problem is to model interactive effects among homogeneous agent pools.[179] This is a

standard technique applied within equation-based models (EBM)—models of ordinary or

partial differential equations—to replicate interactive effects among representative

aggregate actors—such as predator and prey groups. The problem with this technique is

that one must assume interactions have a uniform and continuous impact on all actors

within the same aggregate pool. Aggregate actor pools provide only limited insight into

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[177] Scott Moss, "Messy Systems - The Target for Multi Agent Based Simulation," in *Proceedings of the Second International Workshop on Multi-Agent-Based Simulation-Revised and Additional Papers*, MABS '00 (London, UK: Springer-Verlag, 2001), 1–14.

[178] See Axtell, Robert, "Why Agent? On the Varied Motivations for Agent Computing in the Social Sciences" in Professor Nigel Gilbert, *Computational Social Science*, Volume 1. (Sage Publications Ltd, 2010).

[179] Paranuk, H. Van Dyke et al. "Agent-Based Modeling v. Equation-Based Modeling: A Case Study and Users' Guide," in Lecture Notes in Computer Science, Vol. 1534/1998 (1998), pp. 10-25.

the bottom up dynamics of complex systems. The object-oriented (OO) approach of

ABM, on the other hand, eliminates the need for homogeneity and aggregation.[180] ABM

agents are modeled as independent programming objects. These objects include a

modifiable set of attributes (instance variables) and behavioral rules (methods). The OO

approach allows each ABM agent to possess varying degrees of skill, information, ability

to interact with others, and capability to make decisions.[181] These differences encourage

behavioral heterogeneity because agents respond to their environment using varied

understandings of the world and their place within it. Constructivists have always viewed

state behavior from this internally heterogeneous perspective but, lacking a way to verify

their claims using formal analysis, such research has been open to the rational materialist

critique against reductionism. ABM is the one formal analysis tool that can help

constructivism to address this problem.

The third advantage of ABM is that it is possible to relax the rational actor requirement of

traditional analytical models.[182] Such a move allows ABM to overcome two major

constructivist critiques of rational materialism and formal methods. The first critique

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[180] Gilbert and Troitzsch, *Simulation for the Social Scientist*; Gilbert, *Agent-based models*; Gilbert and Troitzsch, *Simulation for the Social Scientist*, chap. 8.

[181] Epstein, Axtell, and Project, *Growing artificial societies*, chap. 1.

[182] Miller and Page, *Complex Adaptive Systems*, chap. 5; Epstein, *Generative social science*, chap. 1-3; Epstein, Axtell, and Project, *Growing artificial societies*, chap. 1.

highlights the empirical implausibility of full rationality[183] and the second emphasizes the

problem of methodological individualism.[184] ABM uses bounded rationality to address

the first limitation and social adaptation to address the second. In terms of rational

decision-making, ABM agents are almost always boundedly rational satisficers, not the

omniscient utility maximizers of game theory or EBM.[185] Again, this is permissible

because ABM simulations do not seek analytically tractable closed form solutions. Thus,

it is not necessary to assume actors consistently calculate and act upon optimal decisions

to explain how rational behaviors attain equilibrium. ABM agents act upon local

information, their ability to calculate a course of action is limited, and their behaviors are

often suboptimal from the perspective of full rationality. Yet, ABM agents are more than

just rational simpletons. ABM agents are also often adaptive.[186] They can either evolve

through selective pressures or learn to meet the shifting demands of their surroundings

through feedback from the environment and other agents. Of course, evolutionary game

theory has some of these same bounded rationality and adaptive features but ABM

simulations can go beyond strict methodological individualism. ABM agents can

internalize intersubjective knowledge through shared experiences with others, allowing

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[183] Arthur, "Inductive Reasoning and Bounded Rationality."; Simon, *The Sciences of the Artificial - 3rd Edition*, chap. 2 and 4; Gerd Gigerenzer and Reinhard Selten, *Bounded Rationality: The Adaptive Toolbox* (The MIT Press, 2001), chap. 1.

[184] Wendt, "The Agent-Structure Problem in International Relations Theory."

[185] Epstein, Axtell, and Project, *Growing artificial societies*, chap. 1; Axtell, "Why Agents? on the Varied Motivations for Agent Computing in the Social Sciences" in Gilbert, *Computational Social Science* Vol. 1.

[186] Miller and Page, *Complex Adaptive Systems*, chap. 10.

agents to share common methods and attributes. The flexibility of OO design permits this

co-evolution of micro-rules and macro-structures. Thus, an ABM simulation can replicate

the complex empirical reality of the international system in a way that meets the

constructivist understanding of agency.[187]

The fourth advantage of ABM is that it is possible to model a wide variety of micro-level

interaction schemes. As I argue in the previous chapter and demonstrate in the NormSim

model below, this feature can help constructivists gain a better understanding of the scope

of intersubjectivity and norm diffusion. Once again, the flexibility of OO design allows

modelers to implement and test their assumptions using any form interaction structure

(the medium of intersubjective experience). Agent interactions can take place on an

explicit space (representing spatially contingent relations), within a modifiable or

dynamic network (representing socially contingent relations), or any combination thereof

simultaneously.[188] Game theory and equation-based models, on the other hand, either

lack spatial and/or network relations altogether or must use aggregate agent pools to

replicate relationship dynamics. As stated above, this washes away the local interaction

effects responsible for path dependencies and non-linear dynamics.[189] ABM simulation

captures this dynamism in a number of ways, using any conceivable interpretation or

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[187] Ian S. Lustick, "Agent-based modeling of collective identity: testing constructivist theory," 31-Jan-00, http://jasss.soc.surrey.ac.uk/3/1/1.html; Hoffmann, *Ozone depletion and climate change*, chap. 4.

[188] Epstein, Axtell, and Project, *Growing artificial societies*, chap. 1.

[189] Epstein, *Generative social science*, chap. 1-3.

configuration of 'local.' The ability to experimentally manipulate locality effects is clearly not possible empirically nor is it easy to demonstrate how such dynamics impact actors such as states using process tracing or other qualitative description methods. In fact, as shown in the previous chapter, constructivists tend to avoid such complexities so as to be able to justify the importance of norms for state behavior. One concern is that locality effects can potentially undercut the constructivist logic of appropriateness because they highlight norm violations. Yet, overlooking the locality aspect of norm diffusion leads to the logical inconsistencies I outline above—the "logic of stubbornness" of norm entrepreneurs—when constructivists attempt to explain norm change. The NormSim model outlined below shows that it is possible to avoid this problem and to extend our understanding of constructivism in the process.

The final advantage of ABM is its ability to model non-equilibrium dynamics.[190] The combination of the four advantages outlined above makes this possible. However, to understand why such a feature is important to international relations, one must recognize the value of depicting the international political arena as an evolving complex adaptive social system. Rational materialists have been much more critical of this idea than constructivists. Rational materialists have focused almost all their efforts on static equilibrium analysis as a way to develop rigorous falsifiable theories.[191] They have

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[190] Miller and Page, *Complex Adaptive Systems*, chap. 5; Epstein, *Generative social science*, chap. 1-3; Gilbert, *Agent-based models*.

[191] Thompson, *Evolutionary interpretations of world politics*.

avoided non-equilibrium dynamics because they believe a moving picture of international relations is impossible to validate analytically or empirically. In fact, although constructivism is an inherently dynamic paradigm, rational materialists continue to hold constructivists to this same static standard of validation.[192] This criticism puts constructivism in a difficult theoretical position. Constructivism needs to explain both why norms impact behavior and why norm violations are expected. From the static equilibrium perspective of rational materialism, such claims will always appear tautological. Constructivists, on the other hand, believe that rational materialists fail to understanding why the logic of static equilibrium analysis overlooks the complexity and dynamism of international relations. The fact that norm following and norm violating behaviors occur concurrently is simply proof that non-equilibrium dynamics dominate the international system. This is a challenging proposition to uphold because qualitative description is an extremely limited way to validate claims about complex adaptive systems. Limited to traditional methods, constructivists have either had to abandon falsification or explain norm dynamics through the lens of equilibrium analysis. ABM allows constructivism to overcome this paradox to formally investigate the complexities of norm emergence and change.

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[192] For an example, see Moravcsik, " 'Is something rotten in the state of Denmark?".

4.3 A Formal Analysis of Emergent Dynamics

In the above discussion, I have outlined the advantages of using ABM simulation for a formal analysis of constructivism. I believe this approach is necessary to gain a better understanding of the dynamic emergent processes inherent in complex social systems and normative orders. Although this formal approach is relatively new to the social sciences in general and to the field of IR in particular, it does have an early foundation in game theory. There have also been a number of early attempts to use ABM simulation to model complex social dynamics. I believe it is important to highlight these works in order to gain an understanding of how NormSim fits into this domain. I now review some of the early attempts to model norms and IR theory. I also explain how NormSim adopts some of the major insights from these models and how it addresses an important methodological gap in our understanding of norm emergence and change. I have broken this discussion into three types of models. Each model type represents a set of distinct methodological and theoretical differences. First, I show how traditional formal analysis tools such as game theory have been applied to norms. Second, I explain how early ABM models attempted to explain norm conformity dynamics from a common sense rationalist perspective. Finally, I demonstrate how ABM simulations have been used to investigate various aspects of IR theory.

The Game Theory Approach to Norms

The first formal analysis approach to the study of norms comes from game theory. Examples include the models of Edna Ullmann-Margalit,[193] H. Peyton Young,[194] and Christina Bicchieri.[195] These models provide a representative sample of the main game theory contributions to norms research. As these models show, the game theory approach to norms forces one to accept important theoretical commitments that violate the tenets of constructivism. This is because game theory is founded upon the methodological individualism of rational choice theory.[196] Thus, all game theory models assume actors adhere to norms out of rational self-interest. There are typically two purposes behind this research. Game theorists either attempt to explain how norms coordinate actor interests to enable positive collective outcomes or they attempt to rationalize norm following behaviors. Norms are modeled as simple coordinating devices that help actors to converge on the same behavioral equilibrium when multiple potential equilibria exist. To achieve this result, the actors of a game theory model simply use information from prior social interactions to redefine their payoff structures for future decision-making.

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[193] Edna Ullmann-Margalit, *The Emergence of Norms* (Oxford University Press, USA, 1978).

[194] H. Peyton Young, "The Evolution of Conventions," *Econometrica* 61, no. 1 (January 1, 1993): 57-84.

[195] Cristina Bicchieri, *The grammar of society: the nature and dynamics of social norms* (Cambridge University Press, 2006).

[196] For a discussion on the limitations of this approach, see S. Moss, "Game Theory: Limitations And An Alternative," 31-Mar-01, http://jasss.soc.surrey.ac.uk/4/2/2.html.

Coordination occurs when actors learn that cooperation leads to a higher payoff than individual defection. Such a cost-benefit approach overlooks the entire intersubjective basis of norms and it assumes a fixed interest understanding of agency. This leads to the same static drawbacks of neorealism and neoliberalism that I have outlined in the second chapter.

Ullmann-Margalit was one of the first to adopt the game theory approach to understand norm dynamics. Her work attempted to explain why norm following behavior was necessary to secure collectively optimal outcomes in certain social situations. She used the classic Prisoner's Dilemma and coordination games to show that actors who were willing to enforce a norm of cooperation could overcome both individual self-interest and information limitations to achieve a socially coordinated outcome in which all actors were better off. Ullmann-Margalit believed that such an outcome justified the existence of norms simply because it was possible to formally demonstrate how norm following behavior fit the expectations of strict rationality. Young modified this strict rationality assumption to show that it was possible for norm following behavior to evolve over time given more realistic assumptions about agency. Rather than formally deducing the solution to a single-shot coordination game, Young's actors played a series of coordination games, using finite memories to calculate a best course of action from a restricted history of interactions with others. Young also introduced an element of stochasticity, which allowed actors to occasionally make mistakes in their rational decision-making. This was an early example of the noise approach to social complexity

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that I explore further in the next chapter. Such a mechanism enable Young's actors to

converge on multiple equilibria and it also made it possible for actors to shift to new

equilibria over time. Finally, Bicchieri attempted to rework the original rational

foundation of prior game theory norms models to examine norm conformity behaviors

from what she claimed was a constructivist perspective.[197] Bicchieri introduced the

notion of two-level games to explain how rational actors switched from individual self-

interested decision-making to norm following behavior. She argued that actors would

play a mixed motive game when they expected others to violate a norm and a

coordination game when they expected others to conform. In this way, Bicchieri could

account for part of the intersubjective aspect of conformity but she could not explain how

norms would ever emerge or change given this rational conformity-based premise.

The Intuitive ABM Approach to Norms

The second set of norms models I review adopted the ABM simulation approach but

maintained the rational theoretical underpinning of the previous game theory models.

Two representative models of this type include the works of Robert Axelrod[198] and

Joshua Epstein.[199] Both of these models have attempted to move beyond the limitations

of game theory in two crucial ways. First, they have examined the effects of multi-agent

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[197] See Cristina Bicchieri, *The grammar of society: the nature and dynamics of social norms* (Cambridge University Press, 2006): chapt. 1.
[198] Axelrod, "An Evolutionary Approach to Norms."

[199] Epstein, *Generative social science*, chap. 10.

interactions to overcome the representative actor and agent-pooling problems of game theory. This move allowed for the replication of actor heterogeneity, which was important for understanding the path dependent processes inherent in norm development. Second, they extended the evolutionary concept of norm development to further explore the impact of adaptive behavior on norm emergence. In this way, the ABM environment made it possible to replicate the dynamics of a complex adaptive system from the rationalist perspective. The major drawback to these models is that they largely lacked a solid theoretical foundation. Little effort was made to justify the mechanisms responsible for much of the complex dynamics produced within these models. These early works were primarily proof-of-concept studies driven by intuitive or common sense understandings of norms.

Axelrod's Meta-Norms model was one of the first attempts to examine the emergence and evolution of norms using ABM simulation. Axelrod's goal was to show how norms emerged, how they were maintained, and how new norms replace old norms in a population of egoist actors without central authority. Thus, Axelrod simply used ABM to revise and reinforce the game theory understanding of norms. Because of his commitment to rational self-interest, Axelrod used social sanctions to illicit norm following behavior within his model. He also used a "survival of the fittest" scheme—coupling reproduction to the actor's payoffs at the end of each period—to build upon Young's early attempts to explore the evolution of actor strategies over time. Axelrod found that conformity to norms was much more likely when self-seeking actors punished

both norm violators and those who failed to sanction norm violators. The problem with this understanding of norms is that it forces one to assume that conformity is a rationalized behavior and that evolutionary selection is responsible for the emergence of norms. This clearly overlooks both the intersubjective aspect of norms and the fact that many critical norm following behaviors do not require continual rationalization once they have become internalized within a population.[200]

Epstein's Learning to be Thoughtless (LTBT) model relaxed the strict rationality assumption of Axelrod's Meta-Norms model to explain how actors come to act upon norms subconsciously. Epstein was able to accomplish this emergent dynamic with two relatively simplistic rules of agency, which I adopt and extend in the NormSim model. First, Epstein replaced the fixed interests notion of norm conformity with an imitative strategy. In this way, Epstein's agents would adopt the mode behavior in their social sphere rather than calculating the payoff of a given behavioral strategy. Epstein also modified the 'best reply to recent sample evidence' strategy of Young's game theory model to allow agents to adjust their social radii when determining how to behave. Epstein assumed social actors were 'lazy statisticians' in that they would prefer to minimize their rational decision-making whenever possible. To replicate this effect, Epstein's agents would reduce the size of their social radius whenever it was possible to determine the socially acceptable behavior using a smaller sample size. This allowed

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[200] For more on the intersubjective approach to norm internalization, see Finnemore and Sikkink, "International Norm Dynamics and Political Change."

Epstein's agents to act upon a norm without having to continually recalculate its appropriateness. Such norm following behavior would continue until the actor received feedback from its local social neighborhood indicating that the norm had changed. At this point, the actor would once again expand its social radius to reassess the social appropriateness of the current norm. Epstein showed that such behavior could account for local norm conformity effects. He was also able to generate metastable patterns using random noise shocks. I describe below how I have adopted Epstein's local conformity understanding of norms and how NormSim attempts to overcome the theoretical disadvantages of noise shocks to generate self-sustaining metastable orders.

International Relations ABMs

The final set of models under review includes ABM simulations that have adopted an IR theory foundation. I review the models of Lars-Erik Cederman,[201] Ian Lustick,[202] and Matthew Hoffmann.[203] These models demonstrate the feasibility of ABM simulation for theory testing within the field of IR. The major advantage to this work is that it is grounded upon a solid theoretical foundation rather than the intuitive approach of the models in the previous two sections. For example, Cederman's model explored the traditional IR theory of neorealism while Lustick and Hoffmann have examined both the

[201] Cederman, *Emergent actors in world politics*.

[202] Ian S. Lustick, "Agent-based modelling of collective identity."

[203] Hoffmann, *Ozone depletion and climate change*, chap. 4.

identity and norms aspect of constructivism. All three models highlight the advantages of a complex adaptive systems approach for understanding the emergent dynamics of the international system. These works illustrate the limitations inherent in top-down traditional IR theories. They also provide a general template for investigating the logical consistencies of complex theoretical assumptions. This is particularly true for the Lustick and Hoffmann models, as both have shown how to formally operationalize critical constructivist tenets such as the intersubjective nature of norms and identities. I adopt these techniques in the NormSim model. However, I also extend this early ABM work to address the critical aspects of metastability these models overlook.

Lars-Erik Cederman's model was one of the earliest examples of an ABM simulation built upon IR theory. Cederman conducted an ABM experimentation of balance of power theory and nationalism. His goal was to demonstrate how states emerged from the bottom up interactions of smaller polities through power politics. His simulation began with an initial landscape of mini-states some of whom were status quo and others were predators. Each mini-state was endowed with an initial random set of resources to be used for either defensive or offensive purposes. During the simulation, predator states attempted to expand whenever their current offensive resources were greater than the defensive resources of their neighbor. This action resulted in territorial conquest based upon the terms of victory, which Cederman modified from one simulation run to the next. Cederman's primary finding was that neorealist balance of power theory was untenable as a theory of order because defensive balancing opened the door to predator dominance.

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Cederman also used a modified version of this same ABM environment to experiment with various nationalist theories but his results in this respect were much more proof-of-concept than his balance of power work. Cederman's work was an important step in the direction of a generativist approach to IR theory testing. However, I show in the next chapter why his rationalist foundation does not allow for the metastability of normative order.

Ian Lustick's Agent-Based Identity Repertoire (ABIR) model was one of the first ABM simulations to test the theoretical assumptions of constructivism. Lustick focused specifically on the identity aspect of the constructivist paradigm. His goal was to use ABM to gain a better understanding of the dynamics inherent in identity formation and change. In the ABIR model, agent interactions took place on a cellular automata based landscape. Each grid cell represented one of two possible agent types—a basic agent or an entrepreneur—and every agent possessed a repertoire of possible identities—one of which was the agent's active identity. During the simulation, agents interacted within their Moore neighborhood[204] to determine the identity that had attained the highest level of social support at that time. The agents then adjusted their active identity when an alternative identity achieved a significantly greater level of social support than the agent's current active identity. They would also replace poorly performing identities with new

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[204] The Moore neighborhood includes all eight neighbors of a cell to the top, bottom, left, right, and the four diagonals. For a discussion on this and other structures, see Livet, Pierre, Dennis Phan, and Lena Sanders, "Why do we need Ontology for Agent-Based Models?" *Complexity and Artificial Markets*, Lecture Notes in Economics and Mathematical Systems, Volume 614, IV (2008):133-145.

identities through this same mechanism. Lustick's work was important for demonstrating how to operationalize the intersubjective bridge between an agent's social environment and its internal understanding of the world. I adopt his "repertoires" approach to socialization within the NormSim model. However, the major limitation to the ABIR model is that it fails to address the sustained social practice aspect of intersubjectivity. As with the Epstein LTBT model, Lustick's agents abruptly and deterministically switch from one identity (or norm) to the next with no regard for prior social experiences. Thus, the long run dynamics of ABIR (and LTBT) are too closely tied to initial conditions to allow for metastability.

Finally, Matthew Hoffmann's model was the first to explore the emergence and dynamism of norms from the perspective of constructivism. Hoffmann used insights from complexity theory—primarily complex adaptive systems theory—to devise a set of behavioral rules that could replicate the dynamic effects of intersubjectivity. To do this, he combined a socialization mechanism similar to Lustick's with a reinforcement-learning scheme similar to Bicchieri and Young's Bayesian adaptation. This resulted in an internal rule model that agents could use to tune their understandings of the world to the social feedback they received from interactions with others. During the simulation, Hoffmann's agents played the "Pick-a-Number" game. In this game, each agent would choose a number from 0 to 100 in an effort to match or predict the group average—the mathematical mean of all numbers played in a round. The catch was that agents had to use a limited set of rule-based heuristics—each rule mapped to a contiguous, non-

overlapping range of numbers—to choose the number they would play in each round.

Agents would then use the current global average (social feedback) to reinforce their rule

sets (their subjective understanding of the world) so as to improve their predictions in

future rounds (to maintain social appropriateness). Using this internal rule model

approach to agency, Hoffmann was able to replicate two crucial norm dynamics within a

relatively simplistic social setting: norm conformity and change. Hoffmann's model was

significantly less complex than Lustick's ABIR model yet it could generate much more

realistic dynamics. This was because Hoffmann's approach to agency captured the self-

sustaining aspect of norms. I adopt this same approach in the NormSim model and I show

in the next chapter why this mechanism is crucial to the punctuated equilibria of a

metastable normative order. I also explain how to replicate this dynamic without the

random noise and deviant norm entrepreneurs Hoffmann used to generate norm change

within his model. As I outline in the next section, NormSim applies a socially complex

interaction structure to this micro-level foundation to generate metastability.

4.4 NormSim: Model Description

NormSim is an abstract model of the international system used to test the logical

consistency of constructivism. The NormSim model formally demonstrates how the

relatively simplistic behavioral assumptions of constructivism generate complex

metastable norm dynamics given the right socio-structural conditions. The goal of

NormSim is to show that a parsimonious and theoretically consistent explanation of norm

change is possible without violating the basic tenets of constructivism, particularly the

logic of consistency (appropriateness) underpinning norm conformity behavior. This is

important for a formal validation of constructivist logic for two reasons. First, game

theory and abstract norms models—such as those of Axelrod and Epstein—approach

norm emergence and change form the methodological individualist perspective of

rationalism, as opposed to the intersubjective perspective of constructivism. Second,

constructivist attempts to model norm change, such as the norms model of Hoffmann,

require agents (norm entrepreneurs) immune to the logic of appropriateness and noise-

induced mistakes in logic to achieve dynamism. NormSim generates such self-sustaining

change endogenously while maintaining an intersubjective understanding of norms and

adherence to the logic of consistency. In sum, NormSim uses basic constructivist logic to

achieve the local conformity, global diversity, and punctuated equilibrium characteristics

of a complex adaptive social system.

NormSim in MASON

The NormSim model is written in MASON.[205] MASON is an ABM simulation toolkit

(library) designed for the Java programming language. The advantages of using MASON

are twofold. First, MASON provides its own standard simulation functionality, whereas

native languages like C, C++, or Prolog require modelers to implement even the lowest

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[205] For more on the MASON platform, see Sean Luke et al., "MASON: A Multiagent
Simulation Environment," *Simulation: Transactions of the Society for Modeling and
Simulation International* 81, no. 7 (July 1, 2005): 517 -527.

level aspects of a simulation from scratch. The MASON library is broken into three layers of functionality. This layering system allows MASON to separate model and visualization components in an effort to increase execute speeds for simulations consisting of large numbers of agents. The first layer of MASON is a utility layer. This layer includes a random number generator, efficient data structures for storing and accesses simulation data, and various GUI widgets for saving simulation runs or restarting previous runs from a given checkpoint. The second layer is the model layer. This layer includes an events scheduler, various simulation related scheduling utilities, and field identifiers to associate objects with locations in notional simulation space. The final layer is the visualization layer. This layer contains a GUI-based console for experimental controls and a set of panels for visualizing simulation results in runtime. These MASON features allow modelers to make use of pre-packaged simulation functions, avoiding unnecessary simulation artifacts, and focusing development efforts solely on the requirements of a given simulation problem.

The second advantage of MASON is that modelers maintain a high degree of control over model development. MASON provides a basic simulation core but modelers are responsible for all aspects of model design and implementation. Some ABM toolkits, such as JRepast, permit a similar level of programming control but the majority of ABM toolkits, such as NetLogo, require modelers to develop simulations within the highly

constrained languages of their own simulation environment.[206] MASON models, on the

other hand, are written in Java and retain all the functionality and flexibility of the

Object-Oriented Java language. The MASON core is also both easily understood and

easily extensible by proficient Java programmers. This makes it possible to import third-

party packages to extend MASON and MASON models beyond basic functionality. This

was done in the NormSim model to utilize the charting functionality of JFreeChart.[207]

Finally, because the base language is Java, all MASON models are portable among

operating systems. This is crucial both for model collaboration and for back-end

simulations in which model runs are executed on a server or cluster.

NormSim Model Structure

I now describe the major features of the NormSim model. Figure 1 provides a class

diagram of NormSim. As this figure illustrates, NormSim is relatively parsimonious. It

consists of just three Java classes. The first class is the NormSim agent environment. This

class is used to define how NormSim agents interact within their social world. The

NormSim class also contains a number of modifiable simulation parameters that I

describe in detail below. The second class is the Agent class. The Agent class provides a

basic framework for NormSim agency. Every Agent possesses the same set of general

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[206] Cynthia Nikolai and Gregory Madey, "Tools of the Trade: A Survey of Various
Agent-Based Modeling Platforms," *Journal of Artificial Societies and Social Simulation*,
Vol. 12, No. 2 (2009).

[207] For more information on the JFreeChart library, see http://www.jfree.org/jfreechart/.

attributes and behavioral methods but each Agent experiences their world from a unique position within the NormSim agent environment. The final class is the Policy class. The Policy class drives the behaviors of NormSim Agents. Throughout the simulation, NormSim Agents use this Policy class to play a modified version of the "Pick-a-Number" game presented in the Hoffmann model.

The basic objective of the "Pick-a-Number" game is to match the behavior (number) of the other Agents in one's social sphere. This is meant to replicate the logic of consistency dynamic of constructivism. Each round, Agents attempt to a pick a number from 0 to 100 (or any maximum value) that is as close to the group average as possible. The NormSim interaction structure determines the "group" each agent interacts with throughout the simulation. Agents use either the mean or mode to determine this group average depending upon the learning scheme in place. Agents must choose a number using a Policy from their internal model of the world, which contains a subset of potential Policies. Each Policy maps to a contiguous, non-overlapping subset of behaviors (numbers) from the overall set of possible behaviors (numbers). For example, Policy 1 may contain behaviors 0 through 10, Policy 2 may contain behaviors 15 through 25, and so on. As the simulation unfolds, Agents use social feedback (the current mean or mode behavior in their social sphere) to reinforce their internal models. To do this, they simply increment (or decrement) the social support score of each Policy when it matches (or fails to match) the group average. The Policy with the highest score is then used in the next

round. As I show in the next chapter, this relatively simplistic game can result in highly

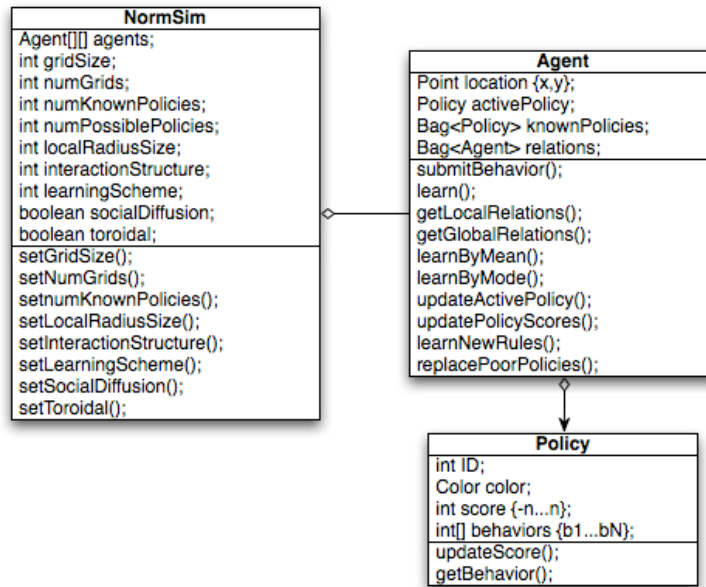complex metastable dynamics given the right social conditions.

Figure 5. NormSim Class Diagram

NormSim Environment

The NormSim environment consists of a (toroidal or non-toroidal) grid of interacting

agents (see figure 2). The total number of agents (or grid size) is set at runtime and can be

modified for experimental purposes. Each grid cell represents a single autonomous agent

with a fixed spatial location. This Cellular Automata landscape is meant to replicate the

geopolitical position of actors in the international system. Although a grid structure

overlooks the complexities of networked relations and mobile actors (migration), I have

shown in the previous chapter that the nearly decomposable nature of the international system makes it possible to examine the social dynamics of the international system from this spatially based perspective. Such an arrangement also allows for a straightforward demonstration of the social circumscription effects outlined in the previous chapter. This is because a grid layout makes it possible to highlight the clustering dynamics of a complex social system in a way that is visually easier to interpret. The Lustick ABIR and Epstein LTBT models use the same approach to examine the impact of local or bounded socialization processes.

NormSim allows one to investigate the effects of a wide range social interaction structures. The baseline interaction structure of NormSim is a global social network—every agent interacts with every other agent in the system. It is also possible to modify this baseline structure to explore regional interactions using any given neighborhood radius size. The various regional interaction structures extend outward from each agent's Moore neighborhood—the eight neighbors to the agent's immediate sides and corners. Such an approach to local interaction results in multiple overlapping social spheres. This has two important consequences for social circumscription. First, the size of the interaction region determines the extent to which agents interact with the same social relations. A small local region enables greater social heterogeneity while a large local region leads to nearly homogeneous social relations. Second, the degree to which regions overlap determines the extent to which agents are exposed to competing interpretations of appropriateness. This is crucial both for the diffusion of new norm interpretations and for

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the establishment of competing critical masses at the regional border. I show in the next

chapter how this form of interaction can generate both local conformity and global
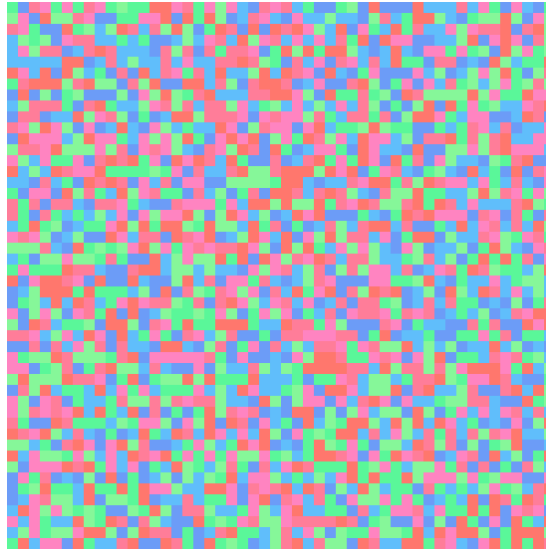
diversity patterns and metastable dynamics.

Figure 6. NormSim Grid. The above figure shows the NormSim grid environment at model start. Each cell represents a single NormSim agent. The color of the cell represents the agent's current active Policy.

NormSim Agents

NormSim agency is closely related to Hoffmann's agency with a few important

exceptions that resemble Lustick's ABIR and Epstein's LTBT models. All agents within

NormSim possess the same three key attributes. First, every NormSim agent is endowed

with a set of known behavioral policies. This set is typically a fraction of the total number

of potential policies available within the system. Each policy is a Java object that

includes a policy ID, a social support score, and a set of potential behaviors—a range of

integers from the policy floor to the policy ceiling. These policies represent behavioral heuristics that encapsulate a range of possible behaviors. The number of policies in the system is important because a higher number of potential policies means that more interpretations of appropriateness are possible while the ratio of total to known policies indicates the level of cognitive complexity each agent faces when interpreting their social context. Second, every NormSim agent has a current active policy. This active policy determines both the grid cell color of the agent and its possible range of behavior in the upcoming round. I explain below how agents calculate and update their current active policy but the basic understanding is that the policy with the highest social support score—from the perspective of a given agent—is the current active policy for that round. Finally, every NormSim agent possesses a set of social relations. This set determines the agent's current social context. Each round, agents interact with all or some of their known relations. They then adapt to the social feedback they receive within this context to determine how to behave in future interactions. As described above, it is possible to modify the interaction structure of NormSim—which determines the composition of each agent's social context—to examine various social circumscription effects. It is also possible to adjust the probability of interacting with agents within this set anywhere from 0 to 1.

NormSim Dynamics: Main Simulation Loop

The main simulation loop of NormSim begins with model initialization. At this point, it is possible to define the model features of interest for experimental purposes. The parameter settings of NormSim can be broken into two categories: interaction parameters and learning parameters. I describe the details of these parameters in the tables below. With these parameters set, the MASON simulator will then generate a random initial grid of agents. Each agent is given a non-repeating subset of initial behavioral policies drawn randomly from the set of total potential policies available. One of these policies is selected at random as the agent's current active policy and all policies receive an initial social support score of 0. Finally, every agent receives an initial set of social relations whom they interact with throughout the simulation. The agent's grid location and the current interaction structure determine which of the other agents in the system belong to this agent's set of social relations. If the grid is non-toroidal, agents at the grid edges receive only those relations that fall within the minimum or maximum grid width and height whereas a toroidal grid allows the set of social relations for agents on the grid edges to overlap either from the bottom to the top or from the right to the left of the grid. A toroidal grid further circumscribes the relationship set of agents at the grid edge, creating more opportunities for "social sheltering."

Table 1. Interaction Parameters

Interaction Structure	Local or global relations
Local Radius Size	Maximum range of the local interaction sphere (0 to any maximum)
Number of Grids	Allows for multiple grids for isolated dynamics (0 to any maximum)
Grid Size	Determines number of agents (0 to any maximum)
Toroidal	True or false

Table 2. Learning Parameters

Number of Known Policies	Total number of Policies per agent (0 to Number of Possible Policies)
Number of Possible Policies	Total number of Policies possible (0 to any maximum)
Learning Scheme	Learn-by-Mean or Learn-by-Mode
Social Diffusion	Agents internalize new policies when exposed (true/false)
Learning Rate	How much to increment or decrement Policy scores (0 to any maximum)
Social Support Threshold	Maximum or minimum Policy score (when to drop)
Behavioral Range	Range of behaviors in a given Policy (1 to any maximum)
Policy Interval	Behavioral gap between Policies (0 to any maximum)
Behavioral Noise	Maximum size of random error term added to social feedback
Directional Noise	Directional random error term (true or false)

Once the interaction and learning parameters are set and MASON has initialized

NormSim, the simulation is then ready to begin. During each round, the MASON

scheduler randomly activates one agent to act at a time until the round has ended. It is

possible to modify this scheduling scheme to examine a variety of activation effects but

the experiments presented in the next chapter use the default schedule settings. This

means that every agent has an equal probability of being activated. Therefore, MASON

may select the same agent multiple times and other agents may not get a chance to act

within a given round. Upon activation, the current active agent steps through a sequence of behavioral and learning methods—illustrated in the flow chart below and described in the following paragraphs. MASON then releases the current agent and randomly activates a new agent to act. This selection process repeats until the MASON scheduler determines the round has ended.
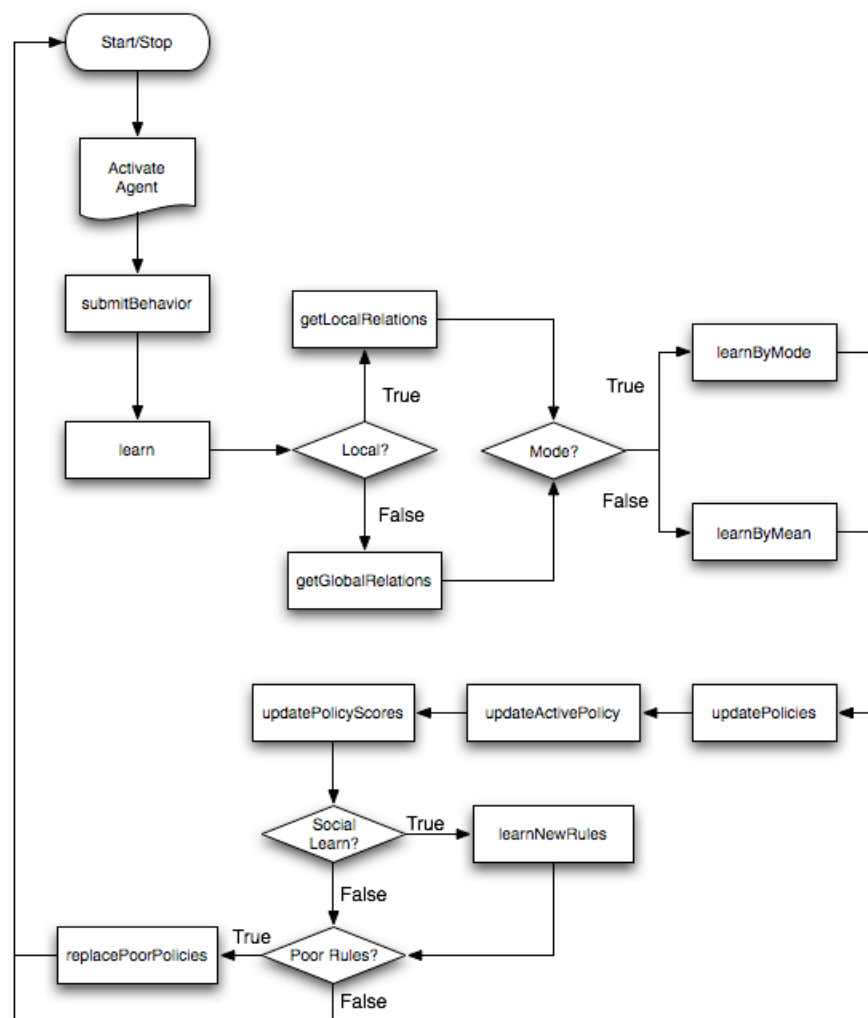

Figure 10. NormSim Agency Flow Chart

The core macro-level dynamics of NormSim emerge and evolve over time in response to the bottom-up micro-level dynamics of NormSim agency. The goal of agency is to maintain a consistent internal picture of the world and to use this subjective understanding to interact with others. Every NormSim agent follows the same sequence of behavioral and learning methods to interact with their social context (see figure 3). Agency begins with action. This action stage is relatively straightforward. Agents simply use their current highest scoring behavioral policy to submit a behavior to the system. To do this, agents draw a random behavior from the set of potential behaviors encapsulated within the current active policy. This number represents the social feedback the current agent supplies to its social context at that point in time. After submitting this behavior, the agent then attempts to learn from the social feedback of others. This can occur in one of two ways depending upon the serial nature of agency. If learning is set to serial, agents step through their learning methods during activation whereas, if learning is set to parallel, agents wait until the end of the round to learn. The learning process itself also depends upon the interaction structure, the learning scheme, and the policy replacement scheme.

The baseline NormSim model uses a global interaction structure, a "learn-by-mean" learning scheme, and a random policy replacement scheme. In this scenario, agents calculate the behavioral mean of the entire system to determine the current socially consistent policy. I explain in the next chapter how this replicates the effects of a "natural

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attractor" policy given that the policy which encapsulates the median of all possible behaviors is almost always likely to be the closest to this mean due to the Law of Large numbers. Once the agent has calculated the behavioral mean, it is then possible to map this value to a potential behavioral policy. In other words, the agent uses the policy that encapsulates this behavioral mean as the current socially accepted policy. The local interaction structure and the "learn-by-mode" scheme both follow this same logic, either replacing the global relation set with a set of local relations and/or using the mode behavioral policy as the socially accepted policy rather than the behavioral mean. Using the socially accepted policy as a guide, the agent then iterates through each of its known policies and increments the social support score of the policy that matches the socially accepted policy or decrements the policy score otherwise. It is important to note that a number of factors outlined in the table above significantly impact this process, including: the learning rate, the maximum/minimum social support threshold, the behavioral range of a given policy, the interval between policies, the ratio of know-to-total policies, and the behavioral noise.

The final stage of agency is to adapt to the current social feedback. This involves two important steps. First, the agent sets its current active policy to the known policy with the highest social support score—in case of a tie the agent chooses either a random policy or the most recent highest policy. The highest scoring policy then becomes the policy the agent uses to determine its behavior the next time the agent is activated. Second, the agent iterates through its known policy set and removes all policies that have reached the

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minimum social support threshold. The agent then replaces each of these poorly performing policies with a random policy drawn from the set of remaining policies. Each new policy receives a social support score of 0—thus, a new policy must receive social reinforcement before it becomes the agents current active policy. The purpose of this "discovery" step is to replicate the mutation effects of evolutionary adaptation. In this way, agents discover new behavioral heuristics through individual experimentation.

Finally, it is also possible to allow agents to learn new policies through socialization. Under the social learning scheme, agents adopt new policies when they interact with agents acting upon a policy that is not currently in their known policy set. As with the "discovery" process, these new policies also receive a social support score of 0. The social learning process is meant to replicate the crossover effects of evolutionary adaptation. Rather than having to discover new policies independently, agents can inherit any potentially successful policy present in their socially circumscribed intersubjective context. The social learning scheme introduces a new level of cognitive complexity in that agents internalize more policies than the capacity of their known policy set allows. Such a situation replicates the effects of cognitive overload and it serves as the basis for social instability in situations in which agents experience high levels of conflicting social feedback within their social context. To minimize this cognitive overload, agents simply evaluate the consistency of their known policies using only a subset of the larger known policies set. The size of this subset is the same as the maximum number of known policies. As a consequence of cognitive overload, agents reinforce only those policies that

fall within this evaluation window. Therefore, some agents may be incapable of

reinforcing the socially consistent policy. I demonstrate in the next chapter why this

dynamic is crucial to metastability.

5. NORMSIM MODEL RESULTS

5.1 Introduction

The current chapter reports the main results of simulation runs of the NormSim experiments—the results depicted within the figures of this chapter reflect a single representative run drawn from a larger ensemble (see Appendix 1 for more details). In this chapter, I show that NormSim follows the computational social science principle summarized by Epstein's generativist motto: "if we didn't grow it, we didn't explain it."[208] These findings demonstrate two things: 1) it is possible to "grow" complex orders from constructivist principles based on my framework in Chapter 3; and 2) it is possible to combine constructivism with insights from complexity theory on social relations to achieve dynamic results without violations to the underlying logic of consistency (appropriateness).[209] The primary goal of this chapter is to demonstrate how NormSim can "grow" metastability.

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[208] Joshua M. Epstein, *Generative social science: studies in agent-based computational modeling* (Princeton University Press, 2006), 67.

[209] In chapter 3, I describe how I have modified the original "logic of appropriateness" explanation from James G. March and Johan P. Olsen, "The Institutional Dynamics of International Political Orders," *International Organization* 52, no. 4 (October 1, 1998): 943-969.

A metastable system is a system that hovers between stability and instability. Oddly enough, it has been easier to explain the stability side of this dynamic than instability. This is because researchers often view instability as if it were something a theory or model needs to overcome to validate its claims. Such an approach to theory or model building is helpful to an extent but a careful examination of instability can reveal important insights into the mechanism of change inherent within complex social systems. To conduct such an examination, it is necessary to establish a clear baseline explanation for stability and then modify this baseline explanation to generate aspects of instability. These modifications should avoid core theoretical assumptions as much as possible in an effort to maintain theoretical traction over the dynamic of interest. This chapter explains how to conduct such an exploration for constructivist theory to better understand the dynamic macro-patterns of the international system.

NormSim seeks to replicate and explain the metastability of complex social systems. The goal is to devise a parsimonious explanation for systemic dynamism. The explanation I propose in chapter 3 requires the least exceptions to the underlying theory justifying how such orders emerge. Interstate norms are the primary emergent order of interest for this study and the theoretical justification for the emergence of this order comes from the IR paradigm of social constructivism. Constructivism posits the logic of consistency (cognitive and behavioral) as the central micro-level cause for the emergence of norms at the macro-level of the international system. Constructivists have undertaken countless

empirical studies to verify the connection between the logic of consistency and normative

order but only one constructivist ABM simulation has analyzed and validated this

connection formally—the CAS-NLC model of Matthew Hoffmann[210] outlined in the

previous chapters. Hoffmann's CAS-NLC model shows that the logic of consistency does

indeed generate bottom-up norm emergence but, as I argue above, his model fails to

achieve dynamism beyond emergence in a theoretically consistent manner. Hoffmann's

explanation for dynamism requires two critical violations to the logic of consistency. The

first occurs when he requires norm entrepreneurs to defy the logic of consistency to

generate new normative orders. The second occurs when he uses random mistakes in

logic to mimic "social noise" in an effort to induce instability. I use the NormSim model

to show that it is possible to achieve this same dynamism without violating the logic of

consistency. I then build upon this foundation to describe how this dynamism leads to

self-sustaining metastability.

5.2 Experimental Results

In this chapter I present results from three major tests of the NormSim model. The first

test-suite (Experiment 1) focuses on the logic of consistency. The goal is to define a

baseline scenario from which to add additional modeling complexity (social complexity).

With this objective in mind, the first experiments outline the conditions necessary for the

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[210] Matthew J. Hoffmann, *Ozone depletion and climate change: constructing a global response* (SUNY Press, 2005), chap. 4.

logic of consistency to generate intersubjective agreement (global homogeneity) in a socially simplistic system. The second test-suite (Experiment 2) builds upon this baseline model to generate the first complex adaptive systems characteristic: the simultaneous attainment of local conformity and global diversity. This test-suite demonstrates the importance of local (socially circumscribed) relations for the emergence of systemic order. The results of this set of experiments reveal two forms of local conformity patters: dynamic resistance and regional clusters. Finally, the last test-suite (Experiment 3) adds social diffusion to the local conformity scenario to generate the full complex adaptive systems macro-pattern, which includes local conformity, global diversity, and punctuated equilibria. This final set of experiments shows that it is possible to generate a dynamic emergent result without violating the tenets of social constructivism. It also provides an opportunity to test the limits of the logic of consistency in a socially complex system.

5.3 Experiment 1: A Stress Test for the Logic of Consistency

Can we achieve non-equilibrium dynamics using the logic of consistency?

The overarching goal of NormSim is to generate metastability using the logic of consistency. I target metastability because it is a defining characteristic of all complex social systems.[211] I emphasize strict adherence to the logic of consistency because it is the

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[211] H. Peyton Young, *Individual strategy and social structure: an evolutionary theory of institutions* (Princeton University Press, 2001); J Holland, *Hidden Order: How Adaptation Builds Complexity*, First Edition. (Basic Books, 1996).

foundation for the bottom-up constructivist explanation of emergent order. The difficulty

is finding a way to account for metastability without violating the core logic of

constructivism. This is because, in order for metastable patterns to exist, it is necessary

for a system to maintain a certain level of instability. Yet, the purpose of the logic of

consistency is to eliminate instability at the micro-level. This then leads to stability at the

macro-level as more and more actors develop the same understanding of the world

through shared experience. NormSim shows what it would it take for a system driven by

the logic of consistency to maintain some instability or disorder so as to provide the

foundation for future systemic change. I demonstrate how the social complexity of the

system itself is responsible for disorder and change. I also argue that, although this

disorder often appears to stem from mistakes in logic, it is actually possible to explain

disorder from a constructivist position. The following set of experiments examines three

modifications to a baseline emergent order model that generate sustained instability and

path dependencies—key components of metastable order. I also explain why these two

features of dynamism are critical to changes in systemic order.

The parameter settings for the baseline NormSim model are set to represent a socially

simplistic system.[212] This baseline model is socially simplistic in the sense that every

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[212] I have modeled the baseline NormSim model after Matthew Hoffmann's baseline
CAS-NLC model. Both baseline models use a simple reinforcement-learning scheme—a
constructivist-inspired modification of Young's "best reply to sample evidence"
algorithm—to play the "pick-a-number" game. Hoffmann devised this baseline model to
replicate the effects of socialization for agents using the logic of appropriateness. This
baseline provides a relatively simple starting point for the social complexity experiments

agent possesses global knowledge of the actions of other agents or, alternatively, every

agent interacts with every other agent simultaneously throughout the simulation.

Although this is an extreme oversimplification of a social system, it provides an idealized

theoretical starting point—one that overstates the case for the logic of consistency—from

which to explore the impact of various aspects of social complexity. The simple face

validity test depicted in figure 1 shows that the micro-rules of the logic of consistency

can in fact generate macro-level order, within an initially disordered system, under these

circumstances. In fact, the global interaction structure of the baseline model and the

presence of a natural attractor[213] ensure the system attains the same ordered equilibrium

almost every time. The only dynamism this baseline model produces occurs as the system

equilibrates. However, such "process" dynamism is always eventually extinguished by

the logic of consistency and the system rarely achieves "outcome" dynamism due to the

natural attractor. This macro-pattern of deterministic global homogeneity is far from the

described below. For a description of Hoffmann's baseline model, see chapter 3 pp 59-64
from Hoffmann 2005.

[213] The baseline model is designed to represent a social system with a natural attractor or
a behavior policy that is intuitively obvious but one that agents must discover through
reinforcement learning. The reinforcement-learning algorithm of the baseline model
requires agents to transform the individual social feedback they receive from interacting
with others into a single aggregate value. Agents simply take the mathematical mean of
all individual values to accomplish this transformation. The mathematical mean results in
a natural attractor simply because all initial behavioral values are randomly assigned from
a normal distribution and the Law of Large Numbers tells us that the mathematical mean
of such a random initial distribution is likely to center upon the median value between the
minimum and maximum range of possible behavioral values. In other words, with a
random initialization from a distribution ranging from 0 to 100, we should expect the
mean value to lie close to 50. Hence, 50—or the behavioral policy that includes 50 as a
possible behavior—is the natural attractor because more agents are likely to begin with
this behavioral value from the outset than any other value.

behavior we expect from a complex social system but it does illustrate the result we should expect from the logic of consistency if we were able to strip away all social complexity. This is an important starting point because, so long as we avoid modifying the underlying behavioral logic of NormSim to achieve dynamism, it is possible to understand and explain the impact of social complexity from a theoretically consistent perspective. In other words, we can only explain systemic dynamism from the constructivist perspective if each alteration to the parameters of the baseline model meet constructivist criteria. This shows how the clearest path to such an explanation is to focus on the sources of social noise in complex systems. I introduce three non-logic-violating sources of social noise—the number of agents, the probability of interaction, and the presence of multiple potential equilibria—into the baseline model to generate higher levels of process and outcome dynamism.
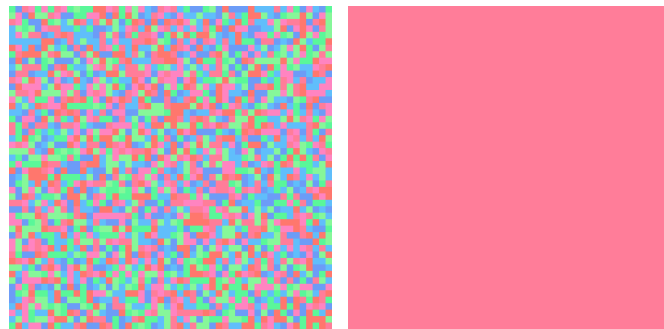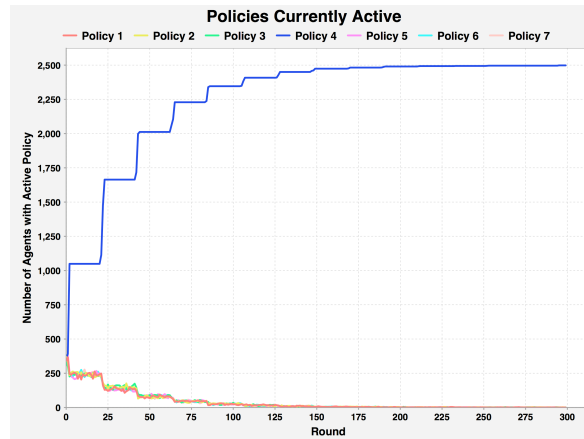
Figure 8. Baseline Results. The NormSim baseline model at simulation start (initialization) and after 300 rounds. Each cell represents a single agent and each color represents the agent's current active policy. The baseline model consists of 2,500 agents (50x50 grid). Each agent uses learn-by-mean reinforcement and the system has a global interaction structure. Each agent possesses 3 out of 7 possible behavioral policies at a time. The simulation begins with agents possessing random initial policies and settles upon the natural attractor policy after approximately 200 rounds. The trajectories are approximately exponential with half-life of about 25-50 rounds.

The most straightforward approach for keeping the baseline model alive—to sustain process dynamism or to achieve outcome dynamism—is to introduce "white" noise. Noise is a popular explanation for dynamism because it is present in all complex social systems in one form or another. Noise impacts both the ability of an agent to follow the logic of consistency and the long run trajectory of the social system itself. A "noisy" system is much less likely to settle upon a global equilibrium than a "non-noisy" system because noise allows for the possibility of interpretation and behavioral "mistakes." These mistakes cascade throughout the system making it difficult for agents to achieve a globally consistent behavior. This effect is readily apparent in figure 2, which compares the long run trajectory of the baseline NormSim model with and without a standard noise

component. Noise, in this case, is simplistically represented as a randomly drawn error

term added to the feedback each agent receives during social interaction. We can see that

higher levels of noise (higher potential error terms) result in greater systemic dynamism.

It is also clear that such dynamism is entirely chaotic—no macro-pattern is apparent. The

logic of consistency is simply unable to filter order from the unordered social feedback of

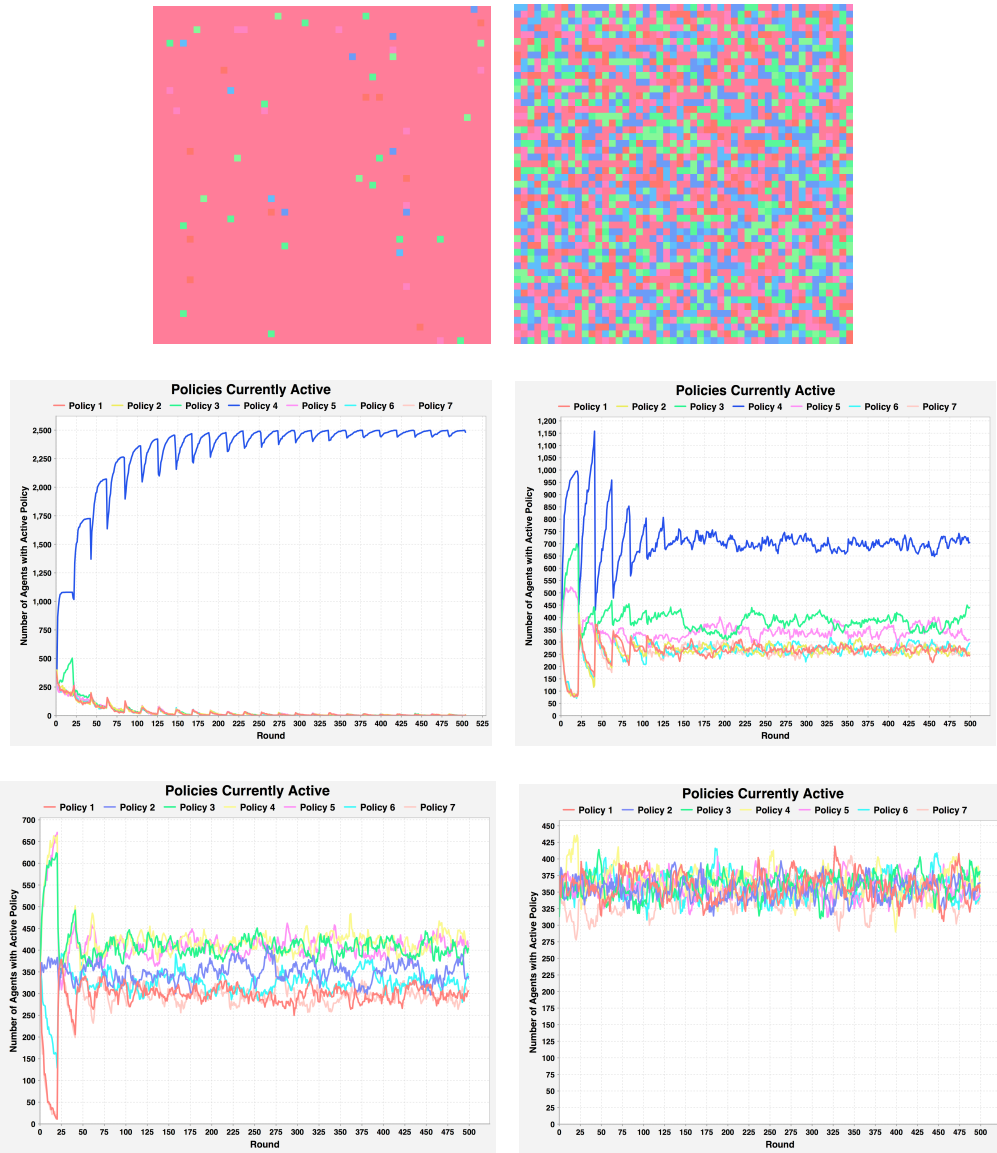a simplistically noisy system, so the system remains chaotic indefinitely.

Figure 9. White Noise Results. The baseline NormSim model with various levels of "white" noise. A random error term drawn from a uniform distribution from 0 to the maximum noise level is applied to each agent's interpretation of the current social feedback. The same model parameters apply as in the first experiment above with the following noise levels: 10, 15, 30, and 50. The top two figures show the agent grid for noise level 10 and 15 after 500 rounds. The four policy charts represent the current active behavioral policies for 500 rounds for each of the four noise levels in order. The ability of the system to attain an ordered equilibrium becomes increasingly difficult as the noise level increases. The impact on the agent grid is clearly different after 500 rounds with noise level 15 as opposed to noise level 10.

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Noise clearly holds the key to unlocking dynamism in a system driven by the logic of consistency. Yet, using a single random error term to capture this effect washes away many of the important features of noise itself. It is easy to see this by observing how sensitive our resulting systemic behavior is to various conceptions of noise with a minor modification to our basic noise parameter. Figure 3 shows that, if for some reason noise is ordered in a way that similar mistakes happen in the same direction, the logic of consistency can generate both process and outcome dynamism. Directional noise pulls the system away from the natural attractor and, depending upon where we place the noise ceiling, the system either settles on a new global equilibrium or hovers around a non-natural attractor equilibrium, with some sustained instability remaining. This result is simple but important for two reasons:

- o First, it shows that a more nuanced and theoretically consistent understanding of noise is necessary to explain the patterned dynamism of a metastable social system.

- o Second, it confirms that directional noise induces patterned dynamism and, since patterned dynamism is what distinguishes metastable from chaotic systems, we should expect complex social systems driven by the logic of consistency to exhibit metastability rather than chaos whenever the system experiences directional noise.

This means that social complexity must have some sort of directional component—it must not be uniformly random—for metastability to emerge from the logic of consistency. Directionality is like an arrow of time in the evolution of social complexity. I argue that the direction of noise comes from the social structure of the system itself and this is something that is not possible to explore using a global interaction scheme or a random noise parameter.
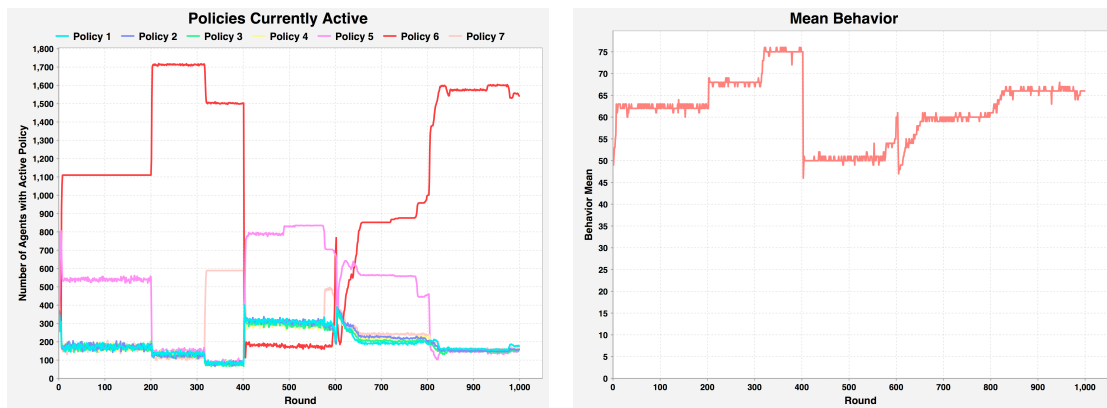

Figure 3. Directional Noise Results. The results of positive directional noise at level 20 and all other parameters the same as the above. The first panel shows the rise and fall of the non-natural attractor policy 6. The second panel shows the impact of this effect on the mean behavior of the system. Directional noise leads to process dynamism—the system continues to evolve—and outcome dynamism—the primary equilibrium of the system is policy 6 as opposed to the natural attractor policy 4.

The standard conception of noise as a singular random error in logic is a convenient way to mimic the complexity of decision-making in a complex social system. The idea is that, because complex social feedback is difficult to interpret (e.g., assigning exactly correct

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messages to received signals, in the sense of Shannon[214]), every agent is likely to

internalize a slightly different message, even if we assume noise-from-signal separation.

Applying a random error term to the feedback an agent receives from the world is meant

to replicate this effect. However, there are two problems with this understanding of noise.

First, noise remains largely a black box concept. There is no clear empirical or theoretical

connection to this simple random error in interpretation other than the fact that common

sense tells us agency is imperfect. We must also accept that social complexity impacts

every agent in the same way and that this impact occurs somewhere in the ether between

agency and structure. This is particularly problematic for a concept that is meant to

replicate social complexity from an intersubjective perspective. As I have argued in

chapter 3, the "social" component of this concept is largely underrepresented when

compared to the "complexity" component. The "complexity" component of a random

error term drowns out the "social" component because all agents make the *same*

interpretation mistakes with *equal* probability. Thus, mistakes with the same magnitude

but opposite sign simply cancel each other out globally, leaving the social impact on

aggregate global feedback entirely dependent upon individual chance fluctuations—the

additive result of multiple private random draws from a uniform distribution. This is why

directionless noise generates systemic chaos but directional noise maintains stability. If

this were really how social complexity impacted the logic of consistency, order would

only be possible in a socially simplistic environment. Yet, metastable order emerges in

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[214] CE Shannon, "Communication in the Presence of Noise," *Proceedings of the IRE* 37, no. 1 (January 1949): 10-21.

socially complex systems despite, or because of, moderate levels of noise. To understand why, we need a better way to operationalize social complexity as a noise parameter.

There are a number of ways to capture the effects of social complexity within a noise parameter without having to use a random error term. For example, we can add more agents to the baseline model and decrease the probability of interaction to represent the disproportionate contributions agents make to the intersubjective message. We can also decrease the number of known policies, increase the number of potential policies, and/or decrease the learning rate to represent the difficulty of translating an intersubjective message into a subjective understanding of the world. These alterations introduce greater social and cognitive complexity into the baseline model but their effect on the long-run trajectory of the system is minimal. The only noticeable difference is that it takes longer for alternative policies to become extinct (see figure 4). In other words, the system temporarily avoids getting locked into the natural attractor equilibrium, which is necessary for metastability, but this effect eventually disappears, along with the potential for systemic change. Alternative policies remain active in this scenario up until the point that agents discover the natural attractor policy. It is possible to use the above modifications to extend this discovery window but the natural attractor, once found, dominates the system. To actually change the emergent order of the system, the logic of consistency needs a reason to deviate from the natural attractor and one that is not simply due to random fluctuations in interpretations. One solution is to relax the assumption that gives a single policy a naturally competitive advantage over all others. The easiest way to

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do this is to switch from learning by the mean feedback of the system to learning by the
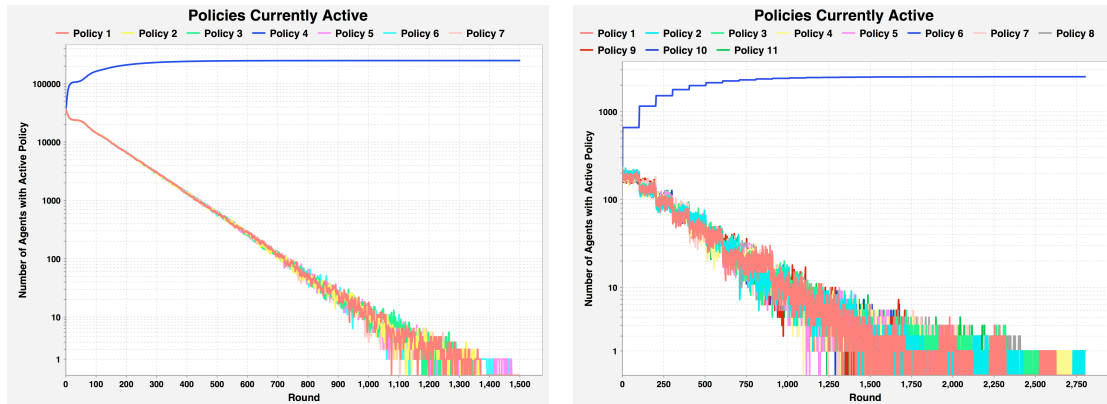
mode.

Figure 11. Extended Noise Results. Extended time to equilibrium attainment in two scenarios. The first result was obtained using 250,000 agents and an interaction probability of 40%. The second result was obtained using 11 possible policies, 3 known policies, and a learning reward of 1 (as opposed to 5). Given both scenarios, the model eventually achieves the natural attractor order but it requires significantly longer time for alternative policies to become extinct when compared to the baseline model. Both the y-axes of these two panels are in log-scale to aid in the visualization this effect.

The learn-by-mean schema is designed specifically to examine the effects of a natural

attractor policy—a policy that is intuitively obvious or logically a better fit for systemic

conditions. This is a rare quality for a policy to possess in a complex social system.[215] It

is also a quality that is unlikely to generate metastability as argued above. For a system to

be metastable, it must be possible for the system to shift from one semi-ordered state to

another (i.e., undergo phase transitions). Alternative policies must be competitive to some

extent. This is only possible in a learn-by-mean schema under rare circumstances (e.g.,

[215] JH Holland, Keith J. Holyoak, and Richard E. Nisbett, *Induction: processes of inference, learning, and discovery* (MIT Press, 1989), chap. 1 and 2.

unique initial conditions). The Law of Large Numbers tells us that the mean behavior of a randomly initialized system—each agent receiving random policies drawn from a uniform or normal distribution of possible policies—should fall near the behavioral midpoint with an increasingly high probability as the number of agents, known policies, possible policies, number of behaviors per policy and so forth increase. The learn-by-mean natural attractor oddly becomes stronger with more potential sources of social noise. On the other hand, the simple switch to a learn-by-mode schema allows each policy to become just as competitive as the next.[216] The consequence for systemic behavior is quite dramatic (see figure 5). This simple change allows the baseline model to achieve outcome dynamism. The system becomes path dependent. It settles upon a different ordered equilibrium each time we rerun the tape of history. The emergent outcome is dependent upon whichever policy establishes a critical mass the fastest—not the discovery of an intuitively obvious policy. This outcome is socially determined rather than the result of a mathematical artifact (the natural attractor) in the learning algorithm. The social history of the system matters for learn-by-mode, but this history still appears to have a final ordered endpoint (global homogeneity). Similar to the learn-by-mean algorithm, learn-by-mode eventually locks itself into an equilibrium that it cannot break. We could shock the system with exogenous noise to send it down a new path (e.g., Epstein's noise shocks) but there is a more endogenous and theoretically satisfying approach to metastability than this. To achieve dynamism, we can relax the extreme

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[216] The basis for this reinterpretation of policy competitiveness comes from W. Brian Arthur, "Competing Technologies, Increasing Returns, and Lock-In by Historical Events," *The Economic Journal* 99, no. 394 (March 1, 1989): 116-131.

global interaction assumption of the baseline model to examine how a local learn-by-mode impacts global dynamics from the bottom-up (reminiscent of the old proverb: "all politics is local").
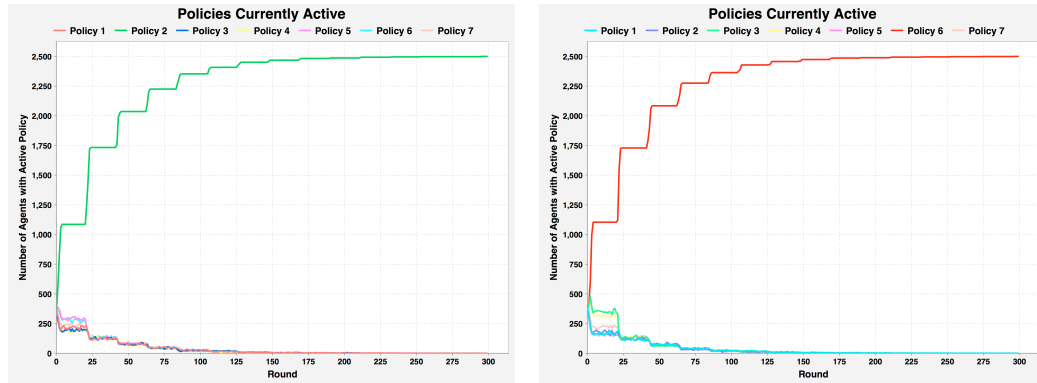

Figure 12. Non-Natural Attractor Results. Results of the learn-by-mode reinforcement scheme in a global interaction structure. Learn-by-mode makes it possible to attain any of the possible policy orders as an equilibrium behavior of the system.

The current section conducts four basics tests on the adaptive logic of NormSim (the logic of consistency). Although these tests were performed in a highly simplistic social setting—when compared to the social complexity of the international system, I argue that it is possible to draw a number of important initial conclusions about IR theory from this work. First, we can see that the presence of a natural attractor plays a key role in shaping the emergent order of the system. So long as a natural attractor exists and the noise level is low enough for actors to interpret the actions of others properly, the natural attractor order dominates the emergent dynamics of this scenario. In a way, this result could be used to demonstrate the bottom-up consequences of the neorealist balance of power explanation for international order. This is because such an idealized social setting

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closely resembles the neorealists view of the international system. In the idealized

neorealist system, one order dominates all others.[217] Thus, it is expected that all actors

will either eventually converge on the natural attractor order—because it is easy to

interpret which order is best through interactions with others (the security dilemma)—or

they will be eliminated from the system—because noise is washed out through natural

selection. However, as I have explained in the second chapter, this explanation for order

is highly problematic. The bottom-up dynamics of this explanation are overfit to a single

emergent pattern from the outset, so it is impossible to explain how systemic order might

evolve over time.[218]

I believe the natural attractor test highlights the severe limitation of explaining emergent

order from a linear and highly idealized perspective. This limitation is so severe because

the assumptions built into such an explanation become self-fulfilling prophecies. No

amount of relaxing these assumptions can explain how the system might shift to a new

emergent order. Bounded or limited rationality in the form of noise simply results in

increasing levels of disorder, as was shown in both noise tests above. This is why an

overfit explanation of order faces a nearly impossible challenge in trying to understand

the long run dynamics of a complex social system. I have shown in the second chapter

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[217] This is the classic balance of power order proposed in Kenneth N. Waltz, *Theory of International Politics*, 1st ed. (Waveland Pr Inc, 2010).

[218] A similar argument is put forth in AE Wendt, "The Agent-Structure Problem in International Relations Theory," *International Organization* 41, no. 3 (July 1, 1987): 335-370.

how neorealism ran into this same problem at the end of the Cold War.[219] Because neorealists had overfit their explanation of order to a single behavioral equilibrium, neorealists could not account for alternative orders or changes in order over time. This left many crucial bottom-up processes completely outside the scope of neorealist understanding, including the entire EU integration project.[220]

In the second chapter of this study, I explained how neoliberalism attempted to overcome the neorealist over-fitting problem to account for alternative orders, such as the cooperative order in place within the EU. Neoliberals accepted the premise of a natural attractor order but argued that it was possible to surmount this competitive path dependency through institutional mechanisms.[221] Neoliberals claimed that states would seek absolute gains rather than relative gains by voluntarily binding themselves to institutional restraints. The other possibility was for states to be so interdependent that defection would be more costly than cooperation.[222] Either way, both situations allowed states to signal a credible commitment to the same collective objective and, hence, states

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[219] Richard Ned Lebow and Thomas Risse-Kappen, *International relations theory and the end of the Cold War* (Columbia University Press, 1995); Pierre Allan, *End of the Cold War : Evaluating Theories of International Realtions*, 1st ed. (Springer, 1992).

[220] Simon Collard-Wexler, "Integration Under Anarchy: Neorealism and the European Union," *European Journal of International Relations* 12, no. 3 (2006): 397 -432.

[221] Robert O. Keohane, "The Demand for International Regimes," *International Organization* 36, no. 2 (April 1, 1982): 325-355.

[222] Robert O. Keohane and Joseph S. Nye, *Power and Interdependence*, 2nd ed. (Pearson Scott Foresman, 1989).

could shift from the natural attractor order (self-help for relative gains) to a new cooperative order (self-help for absolute gains). I argue that it is possible to interpret the results of the directional noise test as a demonstration of this effect. In this scenario, directional noise allows actors to coordinate on the same self-interested deviations from the (balance of power) natural attractor. The direction of the noise itself represents a built in institutional restraint that guides the system to a new order. Of course, the problem with this explanation for order is that it can only explain how orders evolve if it is possible to identify the institutional mechanism responsible for deviations from the natural attractor. Once again, as with the neorealist limitation, I have argued in the second chapter that this makes it difficult to apply neoliberalism to the EU to explain behaviors that fall outside the institutional realm.

The final experimental test highlights a potential constructivist reinterpretation of international order. In this test, I have replaced learn-by-mean with learn-by-mode. This effectively removes the natural attractor and allows the system to travel multiple potential paths towards emergent order. I argue that such a result provides a highly idealized conformation of Alexander Wendt's theory that "anarchy is what states make of it."[223] However, we can also see that this scenario leads to a number of highly questionable dynamics as well. Simply relaxing our assumption about which order the system is likely to attain enables outcome dynamism but the logic of consistency washes away processes

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[223] A Wendt, "Anarchy is what States Make of it: The Social Construction of Power Politics," *International Organization* 46, no. 2 (April 1, 1992): 391-425.

dynamism altogether. This is because, given a global interaction scheme, it is not possible for the system to retain diversity. From this perspective, we could only explain how potential orders emerge and diffuse throughout a social system but not how they evolve over time.[224] If we were to apply such a framework to a complex social system such as the EU, we could not account for norm violations or alternative interpretations of appropriateness. We would be forced to focus solely on the dynamics of norm conformity. I have argued in the chapters above that this is the situation that constructivist frequently face when attempting to validate their complex claims using qualitative analysis. As I show below, constructivist logic can account for complex emergent patterns but this work is often mistakenly criticized from the simplistic theoretical perspective outlined in this section.

The problem with validating theories from this simplistic theoretical perspective is that it forces researchers to pose their explanations for order from a linear and static standpoint. This is problematic for any theory attempting to explain the emergence and dynamism of order in a complex social system. As we can see from the tests above, such theories lead to a single globally homogeneous and path dependent conclusion. However, we know that empirically such results are rare. I have already introduced the Iraq War case as one example of a complex heterogeneous pattern that simplistic theory has a difficult time explaining. The internal division that occurred within the EU at the time of the Iraq War

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[224] A similar argument has been put forth in Martha Finnemore and Kathryn Sikkink, "International Norm Dynamics and Political Change," *International Organization* 52, no. 4 (October 1, 1998): 887-917.

is not something that fits any of the above globally homogeneous solutions. In order to account for this behavioral diversity, we need a theory that can explain the parallel emergence of alternative orders. I show in the next section that adding social circumscription to the simplistic—from the perspective of the current section—theories of neoliberalism and constructivism can allow us to generate such a complex result.

5.4 Experiment 2: Social Circumscription: Local Conformity, Global Diversity

Can we achieve 2 out of the 3 characteristics of complex adaptive systems using the logic of consistency?

Learn-by-mode in Experiment 1 allows alternative equilibria to emerge within the baseline model. This is because it creates path dependencies that lead to outcome dynamism—something we cannot achieve using learn-by-mean. Learn-by-mode is an important step in the direction of metastability but the fixed homogenous global order that results from learn-by-mode is only slightly more socially complex (i.e., barely more realistic) than the natural attractor equilibrium of learn-by-mean. The ordering force of the logic of consistency continues to guide the system down a single irreversible path regardless of the learning algorithm. This is because the global interaction scheme of the baseline model effectively binds the entire system into a single cohesive social unit. Sub-unit interactions are impossible in this scenario. Every interaction is channeled through the same intersubjective conduit. This eliminates the possibility of co-existing orders—

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two or more stable orders at a time. The baseline model either attains a homogeneous global order or no order whatsoever. Complex social systems on the other hand produce a much wider variety of order within the spectrum of possibilities—ranging from homogeneous order to complete disorder. As highlighted in chapter 3 above, one of the defining features of a complex social system is its ability to sustain local conformity and global diversity simultaneously. This result requires a relaxation of the global interaction structure of the baseline model to enable the emergence of competing critical masses.

The global interaction structure of the baseline model in Experiment 1 is much too socially simplistic to generate complex emergent patterns with or without random noise. This is understandable given that global interactions are rare in complex social systems. Almost all interactions in such systems take place at the sub-system level or, at the very least, are heavily impacted by sub-systemic forces. This has important consequences for the logic of consistency and the emergence of order. Because global information is usually inaccessible—or global experience is implausible—in a complex social system, each actor develops a unique perspective on the world. The distinctiveness of this subjective perspective depends upon the social interaction structure of the system itself. Local structures, which encourage an imbalance in the frequency of interaction among actors, produce a wider variety of emergent orders at the macro-level than global structures. This is because local structures reproduce the effect of path dependencies at the sub-systemic level. Rather than the entire social system traveling down the same historically contingent path, sub-systems themselves can develop their own unique

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history of interactions. Such diversity impacts the global diffusion of intersubjective knowledge because it erects subjective buffers through which social feedback must traverse before reaching other actors in the system. In other words, a local interaction scheme makes it possible for certain actors to become "social sinks," permanently or temporarily preventing intersubjective messages from reaching a wider social audience. This confined feedback delay is all that is needed to create the characteristic local conformity and global diversity pattern of a complex social system.

The clearest way to demonstrate the effect of a local feedback delay on emergent order is to replace the global interaction scheme of the baseline model with a nearest neighbor scheme. In the nearest neighbor scheme, interactions take place within a specified range from each agent's current location. A simple representation of this scheme is to have agents interact only within their Moore neighborhood—interactions take place among agents that share borders only—but it is also possible to expand this radius to represent larger "regional" interactions that are still less than global in range. Regardless of the neighborhood size, there are two things to keep in mind about this shift from global to local interactions.

- o First, the nearest neighbor scheme limits direct social interactions to regional bounds but it maintains the connected structure of the global interaction scheme. All agents have at least indirect links to every other agent in the system so the flow of intersubjective knowledge is simply delayed not restricted.

o   Second, the local interaction structure is the same for every agent so any macro-level heterogeneity is due to the timing of interactions within a given neighborhood as opposed to gaps in the neighborhoods themselves. In this way, macro-level order remains an emergent phenomenon that evolves from the bottom-up. The only difference is that the emergent order of a local interaction scheme is more socially complex. It generates a pattern of local conformity and global diversity rather than systemic homogeneity.

Local interactions have a much wider range of impact on the emergence of social order than global interactions. One important consequence is that local interactions can produce distinct regional orders despite the presence of a natural attractor (see figure 6). Such a result occurs when you replace the global interaction scheme of the baseline model with a nearest neighbor scheme of radius 1. This move allows for the establishment of competing regional orders. There are a number of points to highlight from this result. First, we can see that the natural attractor continues to guide emergence but it does not eliminate alternative orders entirely. It is possible for "suboptimal" orders near the natural attractor to remain sustainable over time—such orders are suboptimal solely from the perspective of the natural attractor order. This is because the neighborhood interaction structure causes localized delays in the spread of intersubjective feedback, providing enough time for alternative orders to establish a critical mass at the regional level before agents discover the natural attractor. Once an alternative order is in place, agents within these regions lack the social incentive to shift to the natural attractor. This is how orders

that are potentially suboptimal from the global perspective become socially entrenched regionally. Such suboptimal regional orders are an emergent consequence of a partially independent history of social interactions not some sort of "cultural" defect. We know this because, if we were to rerun the tape of history, the same pattern of global diversity emerges but the location and shape of the regional clusters changes.
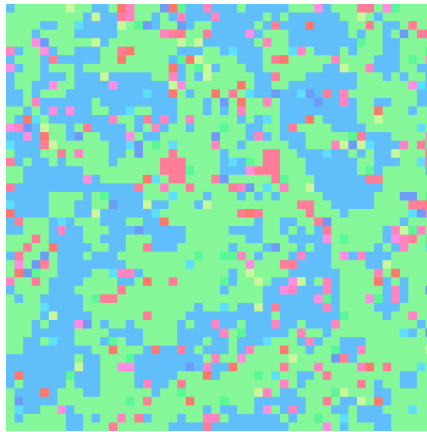

Figure 13. Local Natural Attractor Results. Results of the local interaction scheme with a neighborhood radius of 1 at the end of 500 rounds. The local interaction scheme, with learn-by-mean reinforcement learning, results in thin deviant clusters and indecisiveness at the borders. The natural attractor order in this scenario is the color green while blue represents the next closest policy to the natural attractor.

The second important insight we gain from the local interaction scheme focuses on the border regions of competing orders. The borders between regional orders show a great deal of instability despite the relative stability within regions. Agents on the border frequently adjust their active policies. They often cannot settle upon a policy that consistently fits their social circumstances. This is because agents caught between

competing critical masses are constantly exposed to conflicting interpretations of the world. Such indecisiveness at the border is crucial to the sustainability of non-natural attractor orders. It highlights the social buffer through which intersubjective feedback must travel from the periphery of a region to the core. Agents at the core of an ordered region are only exposed to alternative policies indirectly through the uncoordinated actions of indecisive peripheral agents. The relatively small interaction sphere of the local neighborhood scheme limits the number of neighbors each agent shares in common, which minimizes the intersubjective overlap in the system itself. This heterogeneity in agent relations allows for a disproportionate exposure to conflicting interpretations. Agents at the core experience less social support for peripheral policies than those on the border who belong to neighborhoods with a much higher number of peripheral supporters. Since agents are not exposed to the same social pressures, one's place in the intersubjective chain results in different understandings of the world. This effect holds so long as there is heterogeneity in the way agents access intersubjective knowledge and such heterogeneity is largely a function of neighborhood size.

The third important insight we gain from the local interaction scheme involves the size of the interaction neighborhood. In figure 7, we see that the radius of interaction significantly impacts the regional clustering of the system. The size of the interaction neighborhood is roughly proportional to the degree of regional fractionalization. A smaller interaction radius (1 or 2) results in multiple small or thinly connected "deviant" regions. On the other hand, a larger interaction radius (3 or 4) results in a single, wide-

spanning deviant region. This effect is limiting, however, because a neighborhood radius that is too large (>5) results in the same global homogenous order as the baseline model. The one difference is that large deviant regions initially emerge within this scenario but they eventually dissolve—from the periphery towards the center—over time. The size of the interaction radius impacts the sustainability of deviant orders in a local interaction setting for two reasons. First, a larger radius significantly increases the number of subjective inputs into the portion of the intersubjective pool each agent accesses directly through first-hand experience. This makes it harder to establish a deviant core from random initial conditions because the Law of Large Numbers favors the natural attractor. Second, it also harder to maintain the critical masses that sustain deviant regions when neighborhoods are large because every increase in the neighborhood radius homogenizes the social experiences of each agent—the number of neighbors in common becomes much higher than the number of distinct neighbors among agents. The deviant regional orders that do emerge under these circumstances face much stronger peripheral pressures. Core agents are not only exposed to the natural attractor by a handful of agents on the regional border but by a much larger proportion of peripheral supporters that they now share in common. This results in a cascade effect in which deviant regions slowly dissolve from the periphery towards the center.
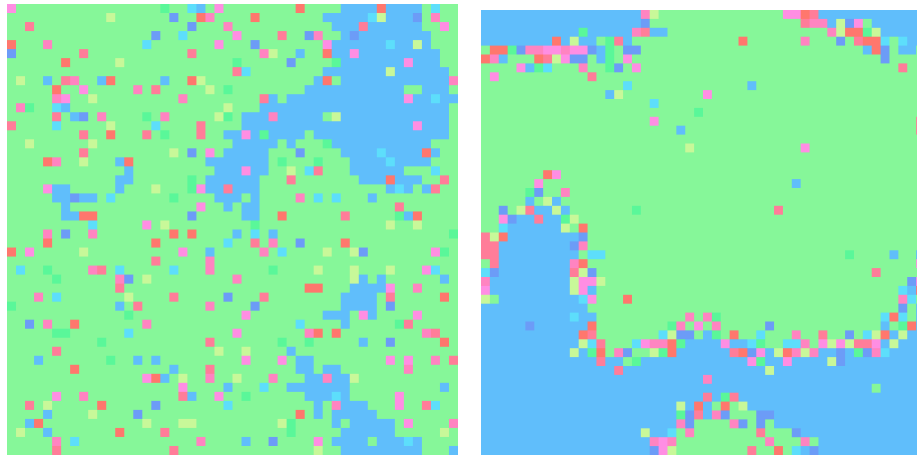
Figure 14. Extended Local Natural Attractor Results. Additional results from the learn-by-mean scheme and local interaction structure. The first grid has a neighborhood radius of 3 and the second grid has a neighborhood radius of 5. Again, the natural attractor order is green and blue represents the order that is the next closest to the natural attractor. In this example, we can see that increasing the neighborhood radius leads to larger and more contiguous, stable deviant orders. We also see a stronger effect of border indecisiveness. A radius above 5 typically results in global homogeneity.

The fourth major insight we gain from local interactions involves the number of potential policies relative the to number of known policies. A one-to-one mapping between possible and known policies clearly favors the natural attractor. There is simply no discovery lag time for an alternative policy to establish a regional foothold. On the other hand, an increase in the number of possible relative to known policies increases the number of trial-and-error interpretations agents must go through to find a socially accepted policy. This factor has two effects on emergent order:

- o First, increasing discovery lag time stabilizes sub-optimal orders in situations in which neighborhood size is large enough for such orders to dissolve naturally (radius >5). Essentially, this move establishes a stronger social buffer between the

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core and periphery of a deviant region, exposing periphery agents to an alternative order for a longer period of time before they discover the natural attractor.

- o However, increasing the discovery lag time in small neighborhoods results in small regional pockets amidst a sea of global chaos. This is because trial-and-error outliers distort intersubjective feedback in smaller neighborhoods much more than larger neighborhoods due to learn-by-mean reinforcement.

These distortions increase the probability of disorder neighborhoods, which in turn increases the disorder between ordered regions. Increasing the neighborhood size effectively reduces this disorder between regions but, again, a neighborhood size that is too large results in the emergence of global homogeneity.

The final insight we gain from a local interaction scheme involves the learn-by-mode algorithm (see figure 8). If we replace learn-by-mean with learn-by-mode, local interactions generate even greater emergent diversity at the macro-level. Rather than two competing critical masses emerging, as in the norm-by-mean situation, multiple competing critical masses remain sustainable over time. This is because norm-by-mode eliminates the notion of a natural attractor, making it possible for each neighborhood to take any one of the multiple potential paths towards emergence. Both the initial conditions and history of interactions within a neighborhood determine which path each neighborhood eventually follows. The size of the neighborhood radius impacts both the number and resulting size of regional clusters. A smaller neighborhood radius results in

multiple small clusters with a higher level of systemic heterogeneity while a larger

neighborhood radius results in a few large clusters and lower systemic heterogeneity.

Again, as with norm-by-mean, increasing the neighborhood size eventually results in

global homogeneity. However, the size of the neighborhood in which it is possible to

sustain systemic heterogeneity is much higher (~10) for norm-by-mode. In sum, although

local interaction alone achieves a minimum of local conformity and global diversity, the

combined effect of local interaction and norm-by-mode allows the baseline model to

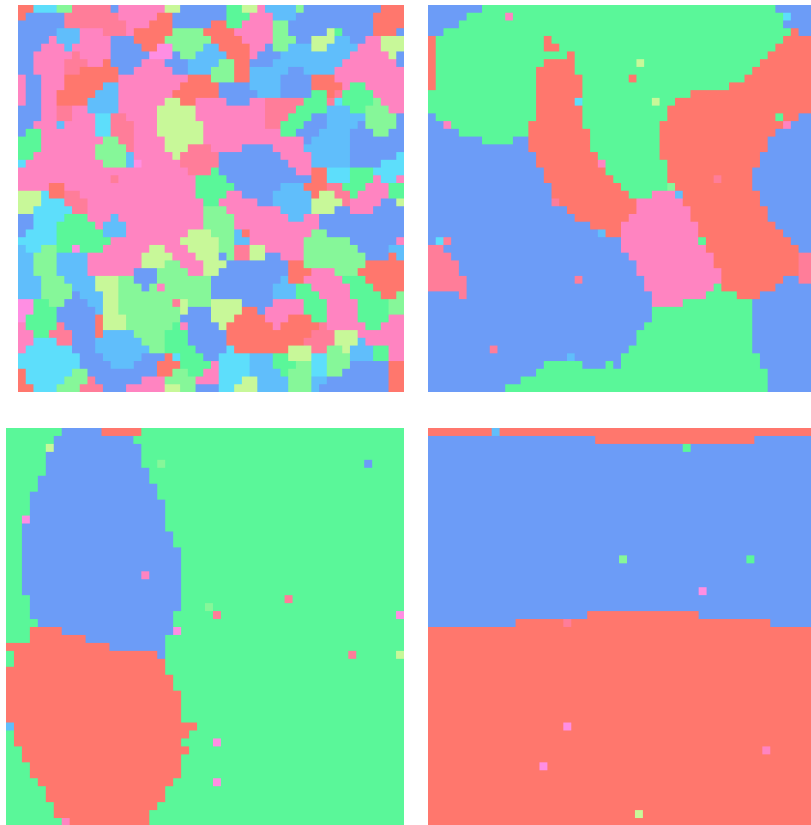generate the full range of emergent complexity.

Figure 15. Local Non-Natural Attractor Results. Results from the learn-by-mode and local interaction scheme. Each grid represents an increasing neighborhood radius size: 1, 3, 7, and 10. Increasing the neighborhood radius results in larger regional clusters with stable orders. This system does not have a natural attractor, as learn-by-mode does not favor one order over another.

From the above experiments, we can see how a local interaction structure provides a new level of social complexity within the NormSim model. Local interactions enable NormSim to generate two out of the three characteristics of a complex adaptive system without violating the logic of consistency. The emergent macro-patterns result in local conformity and global diversity. It is also possible to produce additional complex social features such as indecisiveness at regional borders (using norm-by-mean) and gridlocked regional clusters (using norm-by-mode). The key product of local interaction is the ability

to sustain multiple critical masses and competing emergent orders. This effect creates historically contingent path dependencies in the social feedback agents use to understand their world. Such path dependencies are critical to the sustainability of non-natural attractor or globally diverse orders. I argue below that these competing clusters provide the foundation for systemic dynamism. The local interaction structure described in this section is more socially complex than the global homogeneous order of the previous section but it does not achieve long run dynamism. The emergent macro-pattern is globally diverse but relatively static over the long run. To achieve greater systemic dynamism endogenously, we can modify this local interaction structure to account for the dynamic nature of socialization. I show how to accomplish this systemic dynamism in the next section.

The current section examines the impact that a single layer of social complexity has on the emergent dynamics of the baseline NormSim model. The experimental tests of this section highlight the role of social circumscription from two slightly different theoretical positions. The first set of tests explores this effect from the rationalist natural attractor perspective and the second set of tests demonstrates this effect from the constructivist "anarchy is what states make of it" perspective. Both sets of tests show that local interaction leads to more complex global orders than global interaction simply because social circumscription makes it possible to sustain regional diversity. I argue that these results can help us to understand the extent to which IR theory can account for the social complexity of the international system in two ways.

The first insight we gain from the above tests applies to rationalism. We can see that, in situations in which a natural attractor exists (the first set of tests within this section), social circumscription makes it possible for regions to converge on alternative non-natural attractor orders. However, these alternative orders are never far from the expected natural attractor order of the system. It is possible to interpret this result as supporting the neoliberal critique of neorealist self-help order. After all, the growth of neoliberalism within IR was largely driven by efforts to explain the pockets of coordinated orders within the sea of competitive order posited by neorealist theory. This result is also a potentially stronger bottom-up confirmation of neoliberal theory than the directed noise result of the previous section. Social circumscription allows regions with a slightly different and historically contingent set of initial conditions (high interdependence) to establish alternative (self-interested cooperative) orders that retain most of the same features of the natural attractor (self-help competitive) order.

The bottom-up dynamic produced in the first two tests of this section can help us to understand how regional regimes, such as the EU, might emerge within the international system given the right initial conditions. We can also see that expanding the scope of social circumscription leads to larger regional zones of cooperation. Although this is a highly stylized result, the same argument has been put forth in the past to support the case

for EU enlargement.[225] This institutionalization line of reasoning first appeared in the enlargement stage that brought Spain, Portugal, and Greece into the union and it appeared again during the Eastern enlargement. It has also been considered one of the possible justifications for admitting Turkey into the EU. With this in mind, it is important to note that the experimental results of this section simply demonstrate that social circumscription is a necessary condition for cooperative order in a natural attractor system. Of course, it is impossible to know from this result what are the sufficient conditions needed to sustain cooperation—which type of institutional arrangement (e.g. democracy) enables such cooperation. However, we can see from the current section that social circumscription does somewhat support the neoliberal generative explanation for order.

The above tests can also help us to understand the drawback to a neoliberal bottom-up explanation. Because neoliberalism begins from the neorealist natural attractor premise, it is only possible to achieve limited macro-level diversity. The initial conditions within a socially circumscribed region lead either to cooperative order or to the natural attractor competitive order. In this overfit understanding of order, we lose the ability to explain nuanced differences in behavior that fall outside the relative versus absolute material gains perspective. We are forced to assume that such differences stem from distinct individual state preferences. The problem with this approach is that neoliberals also

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[225] Michael Emerson and Senem Aydın, *Democratisation in the European neighbourhood* (CEPS, 2005).

assume that such preferences are fixed and that institutional restraint is the only path to change. Thus, the only way to account for bottom-up dynamics is to redefine the initial conditions within a socially circumscribed region (e.g. EU enlargement or expanding EU governance). In other words, macro-level diversity is either the product of national preferences, which fall outside the scope of neoliberal explanation, or institutional restraint. I have described in the second chapter how this leaves cases like the internal division within the EU at the time of the Iraq War unexplained. Such a scenario was not a simple case of cooperation versus defection.[226]

The second insight we gain from the above tests applies to constructivism. It is entirely possible to reinterpret the results of the first two tests as partial confirmation of the constructivist explanation for emergent order. This is because the constructivist and neoliberal explanations overlap in important ways. For example, both assume that order is the product of common interests. Thus, both frameworks can explain how such initial conditions lead to cooperative behaviors over time. The major difference between the two is that constructivists believe mutual interests (common worldviews) evolve through social practice not institutional restraint.[227] This means that constructivism can move beyond the dichotomous cooperation versus defection understanding of order to explain

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[226] Jurgen Schuster and Herbert Maier, "The Rift: Explaining Europe's Divergent Iraq Policies in the Run‑Up of the American‑Led War on Iraq," *Foreign Policy Analysis* 2, no. 3 (July 1, 2006): 223-244.

[227] We can see this line of reasoning in the security domain within Emanuel Adler, "Imagined (Security) Communities: Cognitive Regions in International Relations," *Millennium - Journal of International Studies* 26, no. 2 (June 1, 1997): 249 -277.

much more complex macro-patterns. To do this, constructivism relaxes the neoliberal

notion of a natural attractor order. This enables constructivism to explain how diversity

emerges through sustained social practice inside or outside the institutional realm. We

can see the impact of this move in the third test of this section.

In the third test, I have eliminated the natural attractor. This allows the system to generate

greater macro-level diversity. Such diversity is the product of sustained social practices

within socially circumscribed bounds. In situations in which no natural or optimal order

exists, we can see that order is simply the product of historically contingent social

interactions within a socially circumscribed region. I believe it is possible to reinterpret

the internal division within the EU at the time of the Iraq War from this socially

circumscribed perspective. Three distinct socially circumscribed groups existed within

the EU at the time of the Iraq War: a pro-NATO group, a pro-EU group, and a neutral

group.[228] Each had also developed a crucially distinct understanding of appropriateness

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[228] It is important to note that these three socially circumscribed groups had a significant
degree of overlap. In fact, this is the same dynamic we see for the socially circumscribed
norm regions in NormSim. All were members or candidate members of the EU and most
were members of NATO as well. What distinguishes these states from one another, in
terms of which socially circumscribed category each fell into at the time of the Iraq War,
was their path dependent socialization that led to a difference in interpretations of
security norms. In other words, although states with dual membership in the EU and
NATO could have aligned with either interpretation of appropriateness at the time of the
Iraq War, we see that the prior socialization path each state traveled played a role in
determining how each was likely to interpret EU security norms. This was important
because the threat from Iraq was highly ambiguous. Thus, broad or abstract EU (system-
level) security norms were unhelpful in determining how states might respond to this
threat. These states needed to fall back on stable socially circumscribed (sub-systemic)
interpretations of such norms. A detailed discussion of this socially circumscribed effect

regarding security behaviors through socialization within these social spheres. The primary difference among the three centered upon the appropriateness of intervention. The pro-EU group and the neutral states were both opposed to intervention in Iraq because the use of force did not fit their understanding of appropriateness. On the other hand, the pro-NATO states had internalized intervention as an appropriate response to the specific security threat that Iraq posed to the international community.

Leading up to the Iraq War, the international system had been in the process of adapting to a new security environment (the system was moving from disorder to order in this dimension of security).[229] Two non-traditional security threats were becoming increasingly important since the end of the Cold War. The first came from failed/unstable states and the second from non-state terrorist groups. Both posed potentially interrelated threats to the stability of the international system.[230] However, it was clear that the international community had not established a common understanding of how to address such threats at the time of the Iraq War (the systemic order was globally diverse) and it was unclear how the (potential) threat from Iraq fit this pattern (interpretation

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can be found in Daniel Lévy, Max Pensky, and John C. Torpey, *Old Europe, new Europe, core Europe: transatlantic relations after the Iraq war* (Verso, 2005).

[229] Elke Krahmann, *New threats and new actors in international security* (Macmillan, 2005).

[230] For a discussion on how Iraq fit this pattern, see RENEE DE NEVERS, "Imposing International Norms: Great Powers and Norm Enforcement1," *International Studies Review* 9, no. 1 (May 1, 2007): 53-80.

mattered).[231] This was certainly true within the UN but critical divisions were present

within the EU as well. The Iraq War brought this internal division out into the open.[232]

Some were quick to claim that the Iraq War split within the EU was a sign that

Europeanization had failed.[233] They argued that the EU member states that supported US

efforts to intervene in Iraq were openly violating EU foreign policy norms and that this

was a clear demonstration of the EU's inability to socialize its members. The problem

with this interpretation of the Iraq War case is that it was framed from an all-or-nothing

perspective.[234] It assumed that only a single interpretation of appropriateness existed

within the EU and that member states either adhered to or violated this norm. A simplistic

constructivist explanation of EU normative order—such as the globally homogeneous

explanation from the first section above—makes it difficult to understand how the Iraq

War fits within constructivist logic. However, the socially circumscribed reinterpretation

of constructivism presented in this section can potentially explain this complex emergent

pattern.

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[231] David A. Lake, "Two Cheers for Bargaining Theory: Assessing Rationalist
Explanations of the Iraq War," *International Security* 35, no. 3 (April 28, 2011): 7-52.

[232] Philip Gordon and Jeremy Shapiro, *Allies At War: America, Europe and the Crisis
Over Iraq*, 1st ed. (McGraw-Hill, 2004).

[233] Uwe Puetter and Antje Wiener, "Accommodating Normative Divergence in European
Foreign Policy Co‑ordination: The Example of the Iraq Crisis," *JCMS: Journal of
Common Market Studies* 45, no. 5 (December 1, 2007): 1065-1088.

[234] Antje Wiener, "Contested Compliance: Interventions on the Normative Structure of
World Politics," *European Journal of International Relations* 10, no. 2 (June 1, 2004):
189 -234.

In order to understand the differences in EU member states interpretation of appropriateness regarding intervention at the time of the Iraq War, we would need to identify the socially circumscribed groups that made such diversity possible. To do this, we would need to understand how socialization in the security dimension unfolded within the EU prior to the Iraq War. As I mentioned above, it is possible to identity three distinct socially circumscribed groups within the EU that can account for three different path dependent socialization outcomes. First, there was the neutral group.[235] These states had developed clear opposition to the use of force during the Cold War due to unique historical circumstances. This group was led by the neutral Scandinavian states of the EU. These states had shown some signs of Europeanization prior to the Iraq War.[236] They were beginning to internalize the humanitarian component of an emerging EU intervention norm. However, their long identification with neutrality meant that they were not likely to support alternative intervention justifications. It also socially circumscribed these states in the realm of security because their neutrality led them to have only minimal interactions within prominent security groups such as NATO. The neutral group was particularly important to the Iraq War case because this group was responsible for limiting the scope of justifiable action within the newly emerging EU intervention norm. This meant that security actions falling under the EU umbrella were

[235] David Arter, "Small State Influence Within the EU: The Case of Finland's 'Northern Dimension Initiative'," *JCMS: Journal of Common Market Studies* 38, no. 5 (December 1, 2000): 677-697.

[236] Marika Lerch and Guido Schwellnus, "Normative by nature? The role of coherence in justifying the EU's external human rights policy," *Journal of European Public Policy* 13, no. 2 (2006): 304.

somewhat constrained by neutral member opposition.[237] From the perspective of the neutral state's interpretation of appropriateness, the threat posed by Iraq fell outside the scope of justifiable intervention.[238]

The second socially circumscribed group within the EU was the pro-EU group. Former US Secretary of Defense Donald Rumsfeld singled out this group as "Old Europe" at the time of the Iraq War.[239] Rumsfeld was simply highlighting the fact that this group had recently developed a somewhat distant relationship with the US. However, I believe pro-EU is a more appropriate label for this group because it was comprised of some of the major leaders of EU integration at the time, including France and Germany.[240] These states were beginning to see the EU as a potentially autonomous international actor. They also saw Europe's past dependence on the US and the EU's prior history of unilateral external relations as possible limits to this autonomy.[241] Furthermore, around the time of the Iraq War, there had been a strong push towards the strengthening of the EU's

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[237] Anders Wivel, "The Security Challenge of Small EU Member States: Interests, Identity and the Development of the EU as a Security Actor*," *JCMS: Journal of Common Market Studies* 43, no. 2 (June 1, 2005): 393-412.

[238] Spyer, Jonathan, "Europe and Iraq: Test Case for the Common Foreign and Security Policy." *Middle East Review of International Affairs,* Vol. 11, No. 2 (June 2007): 94-106.

[239] Gordon and Shapiro, *Allies At War*.

[240] Another way to describe this group would be "core Europe" from Lévy, Pensky, and Torpey, *Old Europe, new Europe, core Europe*.

[241] Karen Smith, *European Union Foreign Policy in a Changing World*, 2nd ed. (Polity, 2008).

Common Foreign and Security Policy and the European Security and Defense Policy as a way of further increasing the ability of the EU to act as a collective voice for Europe.[242] These moves helped to socially circumscribe the pro-EU group in the realm of security. This group opposed intervention in Iraq on the basis that the coalition forces had failed to gain multilateral support for their actions both within the EU and in the UN.[243] Such opposition focused more on the fact that unilateral action taken by EU member states— and candidate member states—would be detrimental to the EU's identity as an autonomous political actor rather than the specific threat Iraq posed to international security. The pro-EU group had internalized multilateralism as an important justification for intervention and the Iraq War lacked this component.

The last socially circumscribed group within the EU at the time of the Iraq War was the pro-NATO group. The pro-NATO group was primarily led by Great Britain but it included an important contingent from other EU member states as well as a number of candidate member states from Eastern Europe.[244] I label this group the pro-NATO group because they had a recent history of socialization within NATO regarding security issues. This effect was strongest with the British due to their "special relationship" with the US

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[242] John Peterson and Helene Sjursen, *A common foreign policy for Europe?: competing visions of the CFSP* (Psychology Press, 1998).

[243] Gordon and Shapiro, *Allies At War*.

[244] This group is also labeled "new Europe" in Lévy, Pensky, and Torpey, *Old Europe, new Europe, core Europe*.

and long support for NATO as Europe's primary line of defense.[245] The new candidate

member states fell into this group because they had recently become members of both the

EU and NATO as a way to establish political credibility within Europe.[246] The fact that

NATO membership was just as important as EU membership gives us an indication that

NATO had a socially circumscriptive effect on these states within the domain of security.

We can see that social circumscription played a factor in the Iraq War because these

states decided to intervene despite open opposition from fellow EU members. From a

simplistic constructivist perspective, it would appear that this action was a clear violation

of EU norms. However, upon closer inspection, we can see that this action hinged more

on a nuance in interpreting the appropriateness of intervention rather than simply an

outright violation of EU norms.[247] In fact, the justification for intervention was framed

from perspective of the core EU values of democracy, human rights, and international

stability, which the EU had previously outlined as common foreign policy objectives. The

critical area of contention within the EU was whether it was justifiable to intervene in

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[245] Tim Dunne, "'When the shooting starts': Atlanticism in British security strategy," *International Affairs* 80, no. 5 (October 1, 2004): 893-909.

[246] Frank Schimmelfennig, "The Community Trap: Liberal Norms, Rhetorical Action, and the Eastern Enlargement of the European Union," *International Organization* 55, no. 1 (2001): 47-80; Frank Schimmelfennig, "Strategic Calculation and International Socialization: Membership Incentives, Party Constellations, and Sustained Compliance in Central and Eastern Europe," *International Organization* 59, no. 4 (2005): 827-860.

[247] Puetter and Wiener, "Accommodating Normative Divergence in European Foreign Policy Co‑ordination."

Iraq under these premises.[248] Social circumscription played a role in shaping this interpretation of appropriateness as those who supported this intervention also had a history of socialization in the security realm outside the EU. These states felt compelled to support US actions in Iraq but in order to do so this action still had to fit within their interpretation of EU norms.

The current section shows that it is possible to use constructivist logic to understand the emergence of more complex macro-patterns than the globally homogeneous patterns of the first section.[249] The addition of social circumscription provides a mechanism for identifying the source of macro-level diversity. I have shown how this can be helpful for understanding events that are difficult to explain from a simplistic norm conformity perspective, such as the internal division that occurred within the EU at the time of the Iraq War. However, the primary limitation to this bottom-up understanding of macro-level diversity is that it retains the same single-shot path dependent character as the global homogeneous result. The problem with this approach is that it does not give us an indication of how a complex social system is likely to evolve over time. Social circumscription is helpful for understanding cross-sectional events like the Iraq War but

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[248] Elizabeth Pond, *Friendly Fire: The Near-Death of the Transatlantic Alliance* (Brookings Institution Press, 2003).

[249] The intent of this discussion was to demonstrate the opportunity for interpreting the Iraq War through the lens of the results presented within this section. The aim was to highlight the use of ABM as a potential formal analysis tool for such complex studies. For a more detailed review of the Iraq War case from a qualitative perspective, see Puetter and Wiener, "Accommodating Normative Divergence in European Foreign Policy Co‑ordination."

we need more than social circumscription to explain what impact this event might have on the EU moving forward. I show in the next section how to do this with the addition of a social diffusion mechanism.

5.5 Experiment 3: Network Interactions: Local Conformity, Global Diversity, Punctuated Equilibria

Can we achieve 3 out of the 3 characteristics of complex adaptive systems using the logic of consistency?

This final section goes beyond the single-shot emergence of the previous two sections. The goal is to generate metastable macro-patterns using the logic of consistency and a more nuanced understanding of socialization. The macro-patterns produced in this section achieve the three primary characteristics of complex adaptive systems: local conformity, global diversity, and punctuated equilibria. At this point, NormSim has accomplished two of these three sub-goals but the various macro-patterns of local conformity and global diversity have all lacked long run dynamism in the form of punctuated equilibria. This is because the socialization mechanism of prior experiments has narrowly limited social learning to the conformity dimension only. What is missing is a way for agents to retain intersubjective alternatives. Rather than internalize new social knowledge, agents simply ignore feedback unrelated to the current order. This approach to socialization explains why agents conform to norms but it cannot account for the social

aspect of change. As with conformity, social change requires coordinated shifts in intersubjective knowledge. However, such coordination is nearly impossible for agents who independently discover new knowledge and then use this knowledge to adapt to their social world. Coordinated social change, on the other hand, requires both social learning and social reinforcement. This final section explains how to modify NormSim to produce coordinated social change and metastability.

Socialization is more than just a reinforcement mechanism used to establish intersubjective agreement. It is also an important source of new knowledge. The social exchange of knowledge allows actors to overcome the limitations of myopia. Actors can learn about the possibilities of social reality from interactions with others rather than having to discover these realities independently. This greatly accelerates the learning process because new knowledge can rapidly diffuse throughout a social network. Social actors can simply internalize new knowledge and then use experience to determine its fit within social reality. This results in a dual role for socialization as both a mechanism for behavioral reinforcement and a pathway to new intersubjective understandings. The previous two sections have accounted for only half of this process. This is because they have used random evolution instead of social learning to generate potential behavioral alternatives. In other words, agents would replace poorly performing behavioral policies with a random draw from a pool of remaining alternatives. Again, randomization was meant to mimic the complexity of knowledge attainment. This oversimplification was necessary to isolate the impact of various sources of social complexity on the baseline

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NormSim model, including the role of reinforcement learning and local interaction structures. However, with the impact of these mechanisms outlined in the previous two sections, it is now possible to further problematize social learning to generate dynamic emergent patterns in a way that builds upon the previous two features.

The socialization method of the previous two sections results in path dependent lock in because it over-generalizes the feedback agents obtain through interactions with others. It transforms a multi-dimensional intersubjective message into a binary signal so agents can reinforce known policies to fit their current social context. What gets lost in this translation is anything having to do with alternative understandings of the world. Agents ignore all information that fails to match the current socially accepted policy. This makes it impossible for agents to coordinate along alternative policy dimensions because there is no way of knowing which other policies are potentially acceptable. Agents can only access the portion of the intersubjective message that pertains to the current social order so socialization remains a one-way street until this order changes. Such binary logic leads agents to mistakenly assume that all alternative policies are unsuccessful and should be replaced with random new policies despite the fact that some policy alternatives actually have social support within an agent's sphere of interaction. This is problematic for two reasons. First, agents who have yet to internalize the current socially accepted policy fail to learn from socialization altogether. They must independently discover new policies through random trial-and-error before they can begin to positively reinforce one of their known policies. This is a rather socially naïve approach to learning because exposure to

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new policies has no effect on an agent's understanding of the world. Second, because the only criterion for internal consistency is that a policy matches the current social order, agents will not distinguish between alternative policies with and without social support. This means that alternative orders cannot begin to establish a social foothold until the current order dissolves. Irreversible path dependencies develop under these circumstances because agents overfit their internal models of the world to the first order that emerges. To counteract this lock in effect, agents must be able to access the full intersubjective message so they can socially coordinate alternative orders rather than having to relying on random independent alignment alone.

It is possible to modify the basic socialization method of NormSim to allow for the intersubjective transfer of alternative policies by simply letting agents expand their current subset of known policies whenever they are exposed to new knowledge. Rather than having to independently discover potential policy alternatives, agents can use social interaction as a means to new knowledge. Each intersubjectively discovered policy alternative receives the same consideration as a potential fit for the agent's current social context as all newly internalized policies under the random evolution scheme—it is given the same default initial score. The critical difference is that, so long as there is support for a given policy alternative, agents can use social learning to shortcut the discovery process. This allows agents to rapidly gravitate to the alternative ordered paths that now have a chance to develop simultaneously alongside the current social order. A cascade effect can occur when enough agents shift to an alternative policy and set off changes

through further socialization throughout the system. Indecisiveness, primarily due to conflicting social feedback at the regional borders, ultimately activates the punctuated equilibria necessary for metastable order. The overall impact on the long run trajectory of NormSim is then dependent upon the size of the difference between known and possible policies, the type of reinforcement scheme, and the radius of the social interaction structure.

The effect of the social learning mechanism described above changes with both the size of the interaction neighborhood and the total number of policies available when the learn-by-mean reinforcement scheme is in force. First, we can see that social learning has only a minimal impact on the long run trajectory of the system when agents interact globally (see figure 9). The resulting order of the system is the same with social learning as the order produced by random internalization alone. Global interaction and social learning generates systemic homogeneity with agents rapidly shifting to the natural attractor equilibrium. Social learning enables the system to attain the natural attractor equilibrium significantly faster than random internalization because agents gain access to a wider range of policy alternatives through interactions with others. This reduces the time spent discarding poorly performing policies before random internalization finally hits upon the natural attractor. In this way, learn-by-mean reinforcement can begin to promote the natural attractor policy as the agent's current active policy without the learning delay imposed by social blindness. Removing this limitation results in rapid stabilization about

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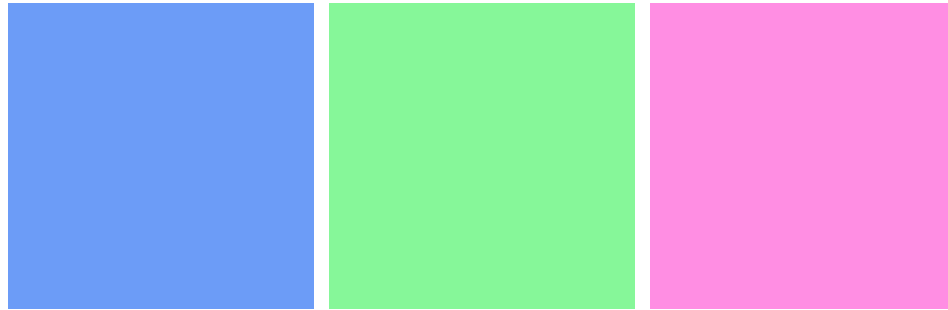the natural attractor when agents interact globally but it has mixed effects when agents interact locally.

Figure 16. Global Metastability. The impact on the learn-by-mean reinforcement scheme using social learning to internalize new policy alternatives rather than random internalization alone. The three grids show results from a global interaction structure while increasing the total number of policies available. From left to right, agents have access to 3 out of 6 possible policies, 3 out of 10, and 3 out of 20. All three scenarios result in global homogeneity. The same result also holds for local interaction structures with a radius greater than 10. Social learning in the global interaction scenario significantly decreases the time it takes for the system to attain a global homogeneous order because agents can access alternative policies instantaneously.

The shift from global to local interaction introduces an element of instability into the long run trajectory of the system with or without social learning. This is because learn-by-mean is more likely to skew social feedback away from the natural attractor with smaller sample sizes. Therefore, local neighborhoods have an incentive to move towards order in opposite directions and the system itself must overcome more instability to achieve equilibrium. As a consequence, random internalization within a local neighborhood of radius 1 can only achieve equilibrium when the number of known policies is relatively close to the total number of possible policies. A known-to-total-policies ratio greater than 3 out of 7 results in systemic chaos. There are simply too many potential policies to

discover through random internalization for agents to align on the same policy at the same time. On the other hand, social learning can temporarily achieve localized stability under these same circumstances. This is because social learning allows agents to share potential policies within their local neighborhood. This helps to offset the instability that occurs during the discovery process. The resulting pattern of localized stability is largely a product of the total number of policies available (see figure 10). As the total number of policies increases, the size and overlap of non-natural attractor orders also increases. This effect is temporary however because the social learning mechanisms eventually diffuses the instability that develops along the regional borders to the rest of the system (see figure 11). Thus, although the system experiences short-lived metastable order, the long run trajectory of the system is either global homogeneity or loosely patterned chaos.
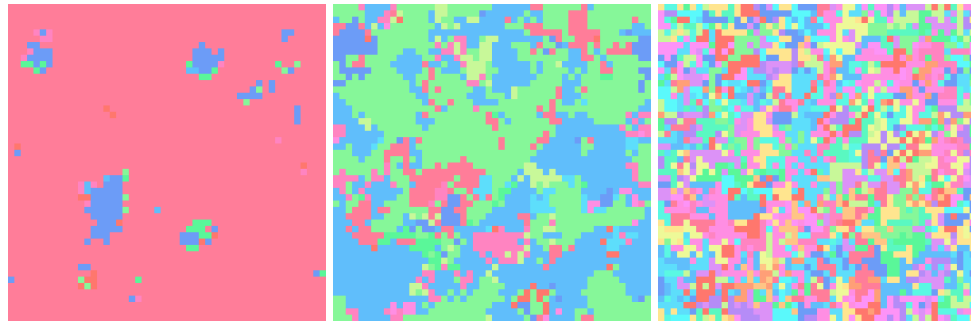

Figure 17. Local Natural Attractor Metastability. The impact of social learning within a local interaction structure of radius 1 while increasing gap between the number of known and total policies. The first grid shows the development of small non-natural attractor orders when agents possess 3 out of the possible 6 total policies. The next grid shows that these deviant regions increase in size when the total number of policies increases from 6 to 10. The final grid shows that an increase from 10 to 20 total policies results in multiple overlapping regional clusters. All three of these grids present temporary orders that eventually dissolve over time. The first grid leads to global homogeneity and the second two grids result in weakly patterned regional clusters that continue to evolve over time but fail to sustain anything beyond ephemeral regional order.
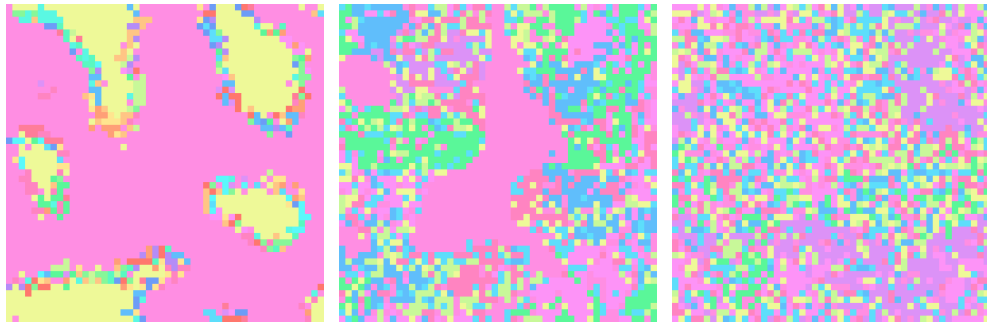
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Figure 18. Extended Local Natural Attractor Metastability. The result of social learning using learn-by-mean and a local interaction structure of radius 3. A slightly larger interaction radius enables the establishment of larger but still unstable ordered clusters. The three grids show the model after rounds 20, 100, and 300. Instability at the regional borders eventually destablizes most of the order established early in the simulation.

It is possible for social learning to generate sustained metastability when we replace

learn-by-mean with learn-by-mode. Learn-by-mode is not prone to local skewing so it is

able to recover from regional instability better than learn-by-mean. Social learning and

learn-by-mode reinforcement allows regions to rapidly reestablish order after temporary

instability. This is particularly important for how ordered regions respond to

indecisiveness at the border. Rather than leading to the break down of systemic order,

instability at the regional borders results in local realignment over time. Thus, the system

achieves local conformity, global diversity, and punctuated equilibria without

succumbing to long run instability. This result is depicted in the time series panel of

figure 12. The panel begins with an initially disorder grid at time 0 (see firgure 12, grid

1). Regional orders quickly develop (see figure 12, grid 2) by round 20 as a result of

learn-by-mode reinforcement within the local interaction radius of 4. The system begins

to experience instability along the regional borders soon after round 150 (see figure 12,

grid 3). This instability continues to grow (see figure 12, grid 4) until it eventually cascades throughout the system (see figure 12, grid 5). Finally, after the social learning mechanism has diffused this instability into the surrounding regions, new regional orders begin to emerge. In sum, the system rebounds from temporary chaos to cycle through new metastable regional orders.

This last result from the NormSim model shows that it is possible to generate metastability with the logic of consistency given the right mix of social complexity. First, it was necessary to modify the global interaction scheme of the baseline model to allow for local interaction. This move enabled local conformity within regional clusters and global diversity at the macro-level. Second, it was also necessary to eliminate the natural attractor so systemic order could develop along multiple paths over time. Replacing learn-by-mean with learn-by-mode both increased the resulting global diversity and further stabilized local conformity. Finally, the addition of the social learning mechanism unlocked the metastability of the system itself. It provided a pathway to punctuate the equilibrium of the system through the diffusion of border instability. Learn-by-mode could then help the system to recover at the local level so the system could establish a new foundation for future metastable change. The final product is a system that achieves local conformity, global diversity, and punctuated equilibrium from the logic of consistency.
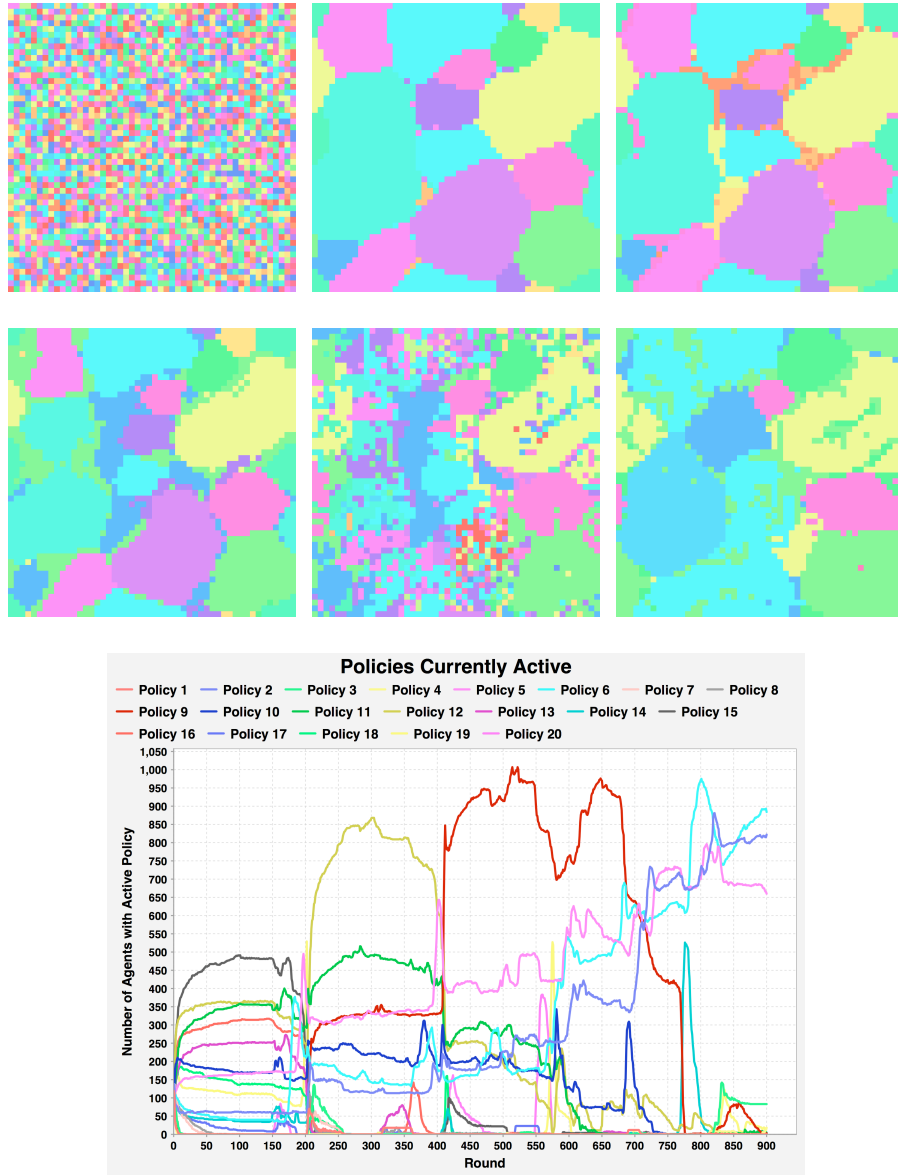
Figure 19. Local Non-Natural Attractor Metastability. The above grid panel shows a time series depicting the impact of social learning and learn-by-mode reinforcement within a local interaction structure of radius 4. The system undergoes metastable evolution over time. The simulation begins with the rapid establishment of regional orders. This is then followed by breakdown at the regional borders and the diffusion of instability throughout the system. Finally, the system recovers and new regional orders emerge.

The results of this final section allow us to examine different ways in which regional diversity can diffuse throughout a complex social system. I have increased the gap between the total and known policies to replicate the effects of increased cognitive complexity. I have also added a social diffusion mechanism that allows agents to share potential interpretations of appropriateness. The results of the above tests give us an indication of the extent to which it is possible to achieve a metastable order from the rationalist and constructivist perspective. We can see from the first test that increasing the cognitive complexity and adding social diffusion has no effect on the emergence of order in a socially simplistic system with a global interaction structure. We can also see in the remaining tests that the addition of social circumscription with these two other factors leads to important metastable dynamics.

In the second and third set of tests, we see how the natural attractor understanding of order results in temporary or highly chaotic metastable dynamics. As the social and cognitive complexity of the system increases, the system fails to achieve a stable order. As with the noise experiments presented in the first section, the natural attractor order makes it difficult to attain anything other than global homogeneity. The system is simply overfit to a given order. Such a bottom-up explanation for order cannot account for the long run dynamics of a complex social system. We see the same problem of overfit in the rational IR theories of neorealism and neoliberalism. These theories can only help us to understand international relations when the rules of the game are known from the outset. However, if these rules change over time, these theories cannot account for this change.

On the other hand, the constructivist explanation for order avoids this problem of overfit because it does not pre-define the rules of the game or the order that is expected to emerge. We can see in the final test of this chapter why such an approach is crucial for our understanding of metastability.

The last test shows that, if we add social circumscription and diffusion to the constructivist understanding of order, we can achieve a true metastable dynamic. This is because the system allows for the co-evolutionary development of stabilizing and destabilizing forces. Such a dynamic result is important for three reasons. First, it shows that heterogeneity is possible within constructivist logic and that social circumscription can account for this effect. Second, it gives us a clearer understanding of a potentially important endogenous source for norm change. We see how an overlapping social context leads to conflicting social feedback. Such norm contestation then leads to disruptions in once stable normative orders. The effect that this has on the long run dynamics of the system depends upon the establishment of a critical mass within this socially conflicted region. Finally, we can see how such instability leads to the emergence of new socially circumscribed orders.

The addition of social diffusion brings us from a single-shot explanation of global diversity to an evolving social system. I argue that it is possible to use such an explanation of order to better understand how complex social systems such as the EU might respond to destabilizing events like the Iraq War. In fact, we see many of the same

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dynamics at play in the final test in the run up to the Iraq War and beyond. First, we can see in panels 1 and 2 how social circumscription leads to the establishment of stable macro-level diversity. This is exactly the same pattern we used to understand the Iraq War division in the section above. However, it is what happens beyond this panel that allows us to gain a deeper appreciation of metastability. In panels 3 and 4, we see how actors caught between competing critical masses develop conflicting interpretations of appropriateness. In the EU case, those within the pro-NATO group were caught between a NATO interpretation of intervention and the EU interpretation of the pro-EU and neutral groups. This instability resulted in increased internal tension within the EU, which we can see in panel 5. After the Iraq War, a new pattern of security interpretations has emerged in response to this destabilizing event. Although it is much too early to tell how the system may continue to evolve moving forward, recent member state actions in Libya give us an indication that a new socially circumscribed order has emerged. This order appears to have brought some of the original conflicting parties of the pro-EU and pro-NATO parties much closer together. We now see an alignment of French and British interpretations of intervention. Yet, the interpretations of the Germans and neutrals remain largely the same. Such realignment is exactly what we see in the final test result of this chapter.

6. CONCLUSION

The current study has argued for a new approach to explaining how order emerges and evolves in the international system. I have shown that the standard explanation for order in the field of International Relations is either too rigid to account for change or too informal to allow for testable research hypotheses. I have proposed the NormSim framework and MASON NormSim model to address these limitations. In this final chapter, I present the main conclusions drawn from the following study. This chapter is broken into two parts. I summarize my research contributions in the first section and I discuss opportunities for future research in the second section.

6.1 Research Summary

This section summarizes the main research findings presented within the study above. In the first chapter of this study, I have proposed three primary research questions that I seek to address using the NormSim framework and MASON NormSim model. The questions were as follows:

1. *How do social norms emerge and evolve to generate order in a complex system?*

2. *Can we use constructivist logic to devise an endogenous explanation for norm change?*

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3. *Can we generate the metastable dynamics of norms and order in the international system using an Agent-Based Model?*

The first question concerns norm emergence, the central theme of this dissertation: *How do social norms emerge and evolve to generate order in a complex system?*

The current study describes the NormSim framework and MASON NormSim model. The goal of NormSim is to explain how social norms emerge through a bottom-up mechanism and evolve to generate order in a complex social system. NormSim is the first computational theory of endogenous norm change to provide a formal specification of the "social" component of "noise" responsible for the emergence of complex and metastable order. Prior norms models have focused almost exclusively on the mechanisms of norm conformity and have relied heavily on "white" noise to generate change. However, such an approach leads to a single-shot and globally homogeneous understanding of norms and it limits our ability to explain the source of new normative orders. The NormSim framework described in chapter 4 is the first to combine the socialization logic of constructivism (the logic of consistency) with the socio-structural complexity of a complex adaptive system (near decomposability and social diffusion) to generate complex and metastable orders using "social" noise. I have shown in the simulation experiments of chapter 5 why this social noise approach is necessary to better understand how the international system retains normative diversity and to identify the sources of new normative orders.

The second question addresses the theoretical role of constructivism:

Can we use constructivist logic to devise an endogenous explanation for norm change?

The traditional IR explanation for order in the international system has been built upon static testable assumptions regarding state behavior, based primarily on material (capability) indicators. Recent constructivist research has shown that such explanations cannot account for changes in order over time, since changes in capabilities are mostly internal to the actors themselves. Constructivists have highlighted the need for an emergent explanation of order but have failed to formally specify the mechanisms necessary to generate this dynamic. Constructivists have also developed a socially simplistic understanding of norms that focuses on the emergence of a single normative order. NormSim provides a formal framework for testing the theoretical consistency of constructivist assumptions in a way that can account for the emergence of multiple norms and metastable systemic orders that compete over time. NormSim is the first constructivist framework to provide an endogenous explanation for change that does not violate the basic tenets of the logic of consistency. NormSim shows how conflicting social feedback between socially circumscribed regions can lead to the development of border instability and the emergence of new normative orders. The emergent phenomenon here can be thought of as a heterogeneous normative landscape populated by a variety of regimes, each composed of a set of norms.

Finally, the third question addresses the capacity of the model to implement the proposed computational theory:

Can we generate the metastable dynamics of norms and order in the international system using an Agent-Based Model?

The NormSim model in MASON conducts a formal test of the assumptions proposed within the NormSim framework, by implementing the theory in an Agent-Based Model. The first set of experiments in chapter 5 shows that the standard IR conceptualization of the international system as a global social arena leads to the emergence of fixed homogeneous systemic order. The addition of socially circumscribed interactions in the second experiment enables the logic of consistency to generate local conformity and global diversity. This test demonstrates how the nearly decomposable interactions of regional international organizations can account for systemic heterogeneity in a way that standard constructivist logic cannot. Finally, the introduction of social diffusion allows for the establishment of competing critical masses within overlapping socially circumscribed regions. It is shown how the normative instability that develops within these regions catalyzes the emergence of new norms and the evolution of systemic order over time. NormSim goes beyond current constructivist explanations of change to outline the mechanisms responsible for the metastable character of the international system.

NormSim overcomes a number of important theoretical and methodological barriers to understand how order emerges and evolves in a complex social system. However, like all

models, NormSim is not without its own limitations. One limitation is that NormSim's

explanation for normative order lacks an identity component. Consequently, it is not

possible to replicate the dynamics of social cleavages, as agents simply internalize social

feedback without a mechanism to connect norms to other agents. A second limitation to

NormSim is that it does not allow for concurrent agent interactions. Migrating NormSim

to a threaded or parallel-distributed processing environment would be a potential

opportunity for future research. However, the serial nature of the current MASON

scheduler cannot reproduce such an effect. A third limitation to NormSim is that it leads

to an explanation for order that may be difficult to convey to a non-technical

constructivist audience. Given constructivism's prior dissatisfaction with the formal

analysis approach of neorealism and neoliberalism, NormSim is likely to face a skeptical

constructivist crowd and one that lacks the formal training to fully grasp its theoretical

implications.

6.2 Future Research

The summary presented in the previous section answers the core questions addressed by

this research project. However, the answers themselves raise a set of additional questions

to be considered in future research. I now discuss a few potential opportunities for future

research extensions to the following study.

The first potential avenue for advancement would be in the realm of spatial and statistical analysis. For example, a potentially fruitful direction in this area would be to track the changes in the *entropy* of the NormSim grid over time. It is expected that the entropy of the system (by Shannon's definition) would fluctuate in line with the metastability of the regional orders. It should be possible to plot a time series of this change in systemic entropy as a quantitative measure of how (and how much) the system transitions from stability to instability. Moreover, quantification of such phase transitions can also permit a Markov process representation to conduct additional quantitative analysis. It would also be possible to measure increases in entropy at the border of norm regimes experiencing destabilizing events. The objective would be to quantify the impact of conflicting social feedback and to assess how this instability impacts systemic order as it diffuses throughout the system. A number of important spatial analysis measures would be possible as well. Spatial measures could be used to calculate the number and size of norm communities (competing regimes) to determine their distributional form—for example, to assess whether clustered regions are normally, Weibull, or Power Law distributed. This would give an indication of the proportional size of competing critical masses and it would be possible to track changes in this proportional mass over time to determine the extent to which the order of the system evolves through each phase transition. Importantly, identifying a given distribution can also suggest a specific generative process. Finally, spatial measures could be used to calculate the number of regional

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borders. For example, Moran's I measure of spatial correlation is an obvious first choice to measure spatial properties of the landscape of competing regimes. A high value in this case would indicate spatial uniformity; values near zero would indicate heterogeneous landscapes; and high negative values would indicate extreme heterogeneity during metastable phase transitions. Therefore, Shannon's entropy H and Moran's I should be correlated: $H \sim I^{-k}$, where k is a scaling parameter. Finally, the proportion of regional borders should be representative of regional "stress," as regions with more normative borders experience greater conflicting social feedback. It is expected that the probability of a destabilizing event should be greater in these high "stress" areas. Such a study would allow for a more formal specification and quantitative measurement of the metastable dynamics within NormSim.

Social Network Analysis

A second opportunity for future research would be the application of social network analysis to the NormSim. Two potential areas of focus would be possible. First, the study could apply pattern recognition methods to identify the centroids of each norm community. Using these centroids as nodes, one could link neighboring centroids to construct a network of regional relations. It would then be possible to perform social network analysis on this structure to calculate the total number of links, the degree distribution of nodes, the size of the network structure, and the betweeness and centrality of nodes. Second, it would be possible to move beyond the current spatial context of the

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NormSim grid to examine the impact of social circumscription within a networked

structure. Such a study could be used to demonstrate the role of nearly decomposable

relations in a way that can account for the socialization effects that unfold within and

among the political structures of regional international organizations. The social network

approach would also allow for the evolution of network relations over time. The focus of

this study would be to replicate the emergent metastable dynamics of NormSim using a

more socially complex interaction structure than the spatial grid of the current study.

Empirical EU Analysis

A third potential opportunity for future research would involve an extended empirical

analysis of the EU case presented within the current study as a relevant case. The goal of

this work would be to track the changes in EU member state justifications for

intervention beyond the Iraq War. Using the dynamics presented within NormSim, this

study would demonstrate the emergence of a new normative order within the EU leading

up to the NATO intervention in Libya at the beginning of this year. The study would

investigate the correlation between EU member state attitudes towards NATO and

justification for intervention in both the Iraq and Libya cases. A more extensive empirical

analysis could be based on additional cases documented in the decades-long history of

the EU.

The NormSim model in MASON has been demonstrably rich in results and has many more potential opportunities for extension than the scope of the current research would allow. NormSim is the first in the line of future research projects that can enable a better understanding of the emergent dynamics inherent within complex social systems.

APPENDIX 1: ROBUSTNESS ANALYSIS

The NormSim experimental results presented in chapter 5 provide a representative sample drawn from a suite of simulation experiments. The results of chapter 5 were reproduced using the same parameter settings (more on this below) to rerun the simulation a minimum of 20 runs each for each experiment and parameter settings (an archive of NormSim movies [.mov files] will be posted separately). The following parameters were used to conduct each of the NormSim tests:

1. *gridSize* – this parameter determines the length and width of the NormSim agent grid as well as the number of agents. It can be set to any value greater than zero. The default value for all three experiments was set to 50 (i.e., 2,500 agents).

2. *maxPolicies* – this parameter determines the total number of behavioral policies available within each simulation run. It can be set to any value greater than zero. The default value for experiment 1 was set to 7, the default value for experiment 2 was set to 10, and the default value for experiment 3 was set to 20.

3. *knownPolicies* – this parameter determines the total number of policies available within an agent's internal rule model. It can be set to any value greater than or equal to *maxPolicies*. The default value for all experiments was set to 3.

4. *maxBehaviors* – this parameter determines the total number of

   behaviors mapped to each policy. It can be set to any value greater

   than 1. The default value for all experiments was set to 10.

5. *learningReward* – this parameter determines the reinforcement

   weight each agent applies to reward (or punish) a successful (or

   poorly performing) policy at each round of learning (each "play").

   It can be set to any value greater than zero. The default value for

   all experiments was set to 5.

6. *learningThreshold* – this parameter determines both the minimum

   and maximum range of a policy score (see *thresholdSD* for more

   details on this parameter). No policy score can be greater than this

   value and no policy score can be lower than the negative of this

   value. Agents randomly replace policies that fall below this

   minimum threshold. This value can be set to any number greater

   than zero. The default value for all experiments was set to 100.

7. *thresholdSD* – this parameter determines the possible range of the

   learningThreshold assigned to each agent during model

   initialization. The *learningThreshold* is drawn from a normal

   distribution with a mean value set to the current *learningThreshold*

   and a standard deviation set to *thresholdSD*. If *thresholdSD* is set

   to zero, all agents will be assigned the *learningThreshold* value as

their current minimum and maximum policy score. Values greater

than zero increase the likelihood that agents will be assigned

different *learningThreshold* values. The purpose of this parameter

is to avoid having all agents replace poorly performing policies at

the same time (this parameter allows for asynchronous updating).

The default value for all experiments was set to 10.

8. *toroidal* – this parameter determines whether the NormSim agent

grid is toroidal or non-toroidal. The default value for all

experiments was set to toroidal (true).

For each of the three experiments presented in chapter 5, the simulation tests were

repeated using the same constant experimental parameters while adjusting the remaining

parameters to establish a "window" of robustness. The goal was to ensure robustness

through a range of parameter values beyond the parameters used to conduct the

experiments of chapter 5. This meant that the expected target pattern was replicated for

each experiment, according to the following expectations/targets:

1. For the first set of experiments, the expected target pattern was global

homogeneity.

2. For the second set of experiments, the expected target pattern was stable regional

clusters.

3. For the final set of experiments, the expected target pattern evolved from initial systemic disorder to regional order. This regional order was then punctuated by border instability and this pattern would repeat over time.

These results were shown to be robust to a number of parameter modifications. For example:

1. Both the size of the grid and the toroidal architecture were shown not to impact the results.

2. It was also possible to replicate the results with incremental changes to the total number of policies, known policies, and behaviors per policy.

3. These results were also replicated with incremental changes to the learning parameters, increasing and decreasing the learning reward, learning threshold, and the standard deviation of the learning threshold.

4. The learn-by-mean results were replicated with low (5%) levels of "white" noise.

5. Finally, the local interaction results were replicated with a modified Small World rewiring scheme in which a small number of local relations would be replaced with distant relations.

APPENDIX 2: NORMSIM README DOCUMENTATION

This appendix describes the steps used to code, compile, and execute the NormSim model in MASON. The primary coding of NormSim was done on a Macintosh machine running Mac OS X 10.5.8 within the Eclipse Software Development Kit. The version of Eclipse was Galileo 3.5.2 (http://www.eclipse.org/downloads/). The NormSim program was developed using the Java 5 programming language. The MASON library version 14 was used for simulation functionality (http://www.cs.gmu.edu/~eclab/projects/mason/). The following packages were also used: Colt 1.2 for randomization features (http://acs.lbl.gov/software/colt/), JFreeChart 1.0.1 for charting functionality (http://www.jfree.org/jfreechart/), and the standard Java libraries available on the MASON library download page.

To compile the code, one must include the previous libraries within the same Eclipse project. There are two main classes used to execute NormSim. One can compile and execute the code using the Eclipse Run function, selecting either the NormSimUI main class (a Graphical User Interface version of NormSim) or the NormSim (a non-GUI version of NormSim) main class. Upon execution, the user will see the MASON simulation console. To set the parameters, one must choose the Model tab. To run the program, the user must press the play button on the MASON console.

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