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Quantifying and Forecasting Vulnerability to Dyadic Conflict in an Integrated Assessment Model: Modeling International Relations Theory

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QUANTIFYING AND FORECASTING VULNERABILITY TO DYADIC CONFLICT IN AN INTEGRATED ASSESSMENT MODEL: MODELING INTERNATIONAL RELATIONS THEORY

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ABSTRACT

The character of state interaction matters. This dissertation quantifies this interaction from 1960-2001 and then forecasts it from 2010-2050. I contribute to the field of International Relations by improving traditional measures of Realism and Liberalism, quantifying new perspectives sensitive to cultural interaction, and statistically evaluating these indices relative to the occurrence of conflict. It is the first step in an academic research agenda that desires to expand the scope of possibility regarding the modeling of International Relations theory for the purpose of theory evaluation and policy analysis.

This dissertation spans two fields of study that do not typically overlap: International Relations and Integrated Assessment Modeling. I begin by laying a broad foundation to bridge this chasm. I do this by first exploring knowledge constraints associated with forecasting. This leads to an overview of my conceptual and empirical tool for calibrating my final model: the historic occurrence of international conflict. Next, I introduce conceptual and applied systems theory, which leads to an overview of the International Futures (IFs) model.

I then explore Liberalism and Realism as they have been traditionally operationalized at the macro-level. A newly quantified variable—referred to as the Cultures of Interaction Index— is introduced that builds on Liberal notions and tries to explain some aspect of intersubjective norms and values operating in a dyad. I perform statistical analysis on these indices and show that using IR theories in conjunction explains more of the historic occurrence of conflict—and thus the character of state interaction—than using any theoretical tradition in isolation. I then endogenize Liberalism and Realism in IFs and use the cultural measure as an exogenous constant. I am interested in whether the stock of culture in a dyad and growth in Liberal notions of interdependence can off-set negative pressures arising from Realism.

Most dyads improve their character of interaction to 2050, but some become more conflictual, including China – US and China – India. The analysis is extended by looking at long-term structural shifts in the global system: depleted fossil fuel reserves, stressed fresh water availability and tension from domestic instability. I conclude by offering a series of next steps that builds upon this work and recommendations for policy planners concerned with the future of interstate relations.

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1. Introduction and Overview

The character of state interaction matters. Cooperative engagement among dyads can foster human development, economic growth and peace. Non-cooperative or conflictual dyads can become mired in vicious cycles potentially leading to armed conflict. The 20th century witnessed the consequences of the most destructive output of poor state interaction: large-scale war killing millions of people and destroying trillions in capital.

International Relations (See Box 1, below) provides plausible explanations—many empirically verified—for why state dyads respond differently to internal and external conditions. IR has been historically dominated by rationalist debates between two theoretical approaches: Liberalism and Realism.[1] Liberals, on the one hand, argue that high levels of interdependence lead to more pacific, mutually beneficial long-term

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[1] Throughout this project I capitalize Liberal and Realist to emphasize that I am highlighting an ideal-type representation of these substantive theoretical positions within IR. Neither position is a monolith, but their operationalization at a macro level treats them similarly.

Additionally it is important to emphasize at this early stage that the primary goal of this project is the quantification and forecast of theory. Thus, it neglects theoretical work done at the margin of each main theoretical position. For example, I am not interested in the multiple variations of balance of power theory, or democratic peace theory. Instead, I am interested in the fact that material power is important for Realists and interdependence is important for Liberals and how these have been traditionally operationalized.

relations. Realists, on the other hand, point to the importance of international anarchy which creates uncertainty about state survival and requires that states focus on the accumulation of relative material power (defined in various ways). A third approach has been developed over the last two-plus decades. This approach is characterized by non-rationalist accounts of state behavior. These new theories largely use constructivist methods that emphasize the role of language, ideals, norms, and culture, which are understood to be created and evaluated through inter-subjective meaning-making. These alternative accounts have gained traction in providing explanation for state behavior, but they have not supplanted the broad, explanatory power provided by previous Liberal and Realist theories about state behavior in the international system.

Box 1: Typology of Theory:

International Relations (IR) is a *sub-field* (I will refer to it as a *field* in this dissertation) within the discipline of Political Science whose subject is the behavior of states. Realism and Liberalism are both *substantive approaches* to doing the work of IR that make similar ontological, epistemological and methodological assumptions and choices about their subject of inquiry and come to generalized conclusions about state behavior. I refer to Realism and Liberalism as *standard bearer accounts* as well for the reasons listed above. Constructivism is not a substantive field, but a *method of inquiry* that privileges the exploration of intersubjective meaning as a driver of state behavior. It is not a *substantive approach*—like Realism and Liberalism—because it comes to no generalized conclusions about the behavior of states in the international system.

Theories are sets of principles and assumptions used to create hypotheses within academic fields. Within IR, theories provide analysts with frameworks for evaluating how changes in the environment are likely to impact state behavior. Each theory—whether a *substantive approach* (like Liberalism or Realism) or a *method of inquiry* (like

Constructivism)—offers information that can help humans more accurately understand state interaction and behavior. The quantification of theory can extend the utility of an abstract theory by forcing making theoretical assumptions to be explicit, testing theories against other quantified variables and producing objective measures that can be formally modeled for the purpose of planning for the promotion of human development.

Since state behavior matters and IR provides tools for assessing this behavior, a forward-thinking policy analyst should be interested in forecasted, quantified IR theories. Large structural shifts loom on the long-term horizon: transitions in national material capabilities, changes in international organization penetration, reductions in fossil fuel resources, changing availability of fresh water resources, and destabilizing impacts from state fragility. How these trends impact dyadic state behavior may be important enough to warrant the establishment of institutions and resources that reasonably can mitigate plausible negative scenarios.

There is currently no model to forecast the character of bilateral state interaction—explained in more depth below and introduced in Box 2—that is quantified, modeled as being integrated to other key global systems, and that deploys a long-term horizon. This dissertation remedies this deficiency by quantifying IR theory (from 1960 to 2001) and endogenously forecasting it within the International Futures (IFs) integrated assessment tool from 2010 to 2050. This first chapter lays the foundation for this tool-building exercise by introducing this project in general terms. Forecasting is not a well understood activity within IR, and IR theory is not well understood within the forecasting community. Because I rely heavily on both fields, this chasm in familiarity compels me to take multiple steps back to shape expectations about my scope.

The first block laid in this dissertation foundation identifies the kinds of things that we can and cannot reasonably say about the future. This is the focus of the first half of Chapter 2. The future is fundamentally unknowable, but we plan *as if* we have some insight on what lies around the next bend in history. I refer to this as the "problem of the future", characterized by our fundamental need to prepare for a future that we fundamentally cannot know. To plan effectively we need to seriously consider what kinds of things we can know about the future. Variables that we can be modeled over long time horizons are those with well understood stocks and flows. It is possible to forecast both continuity *and* change in these cases.

Box 2: Character of State Interaction

We know when two states have better or worse characters of interaction. States that have enduring international rivalries (like India and Pakistan) have relations that are characterized by conflict. Most members of the European Union have relations that are characterized by cooperation. Quantifying this historically is difficult and requires a dependent variable that represents the character of state interaction. For this project the onset of conflict is used as this calibration tool as it represents a character of bilateral interaction that is fully deteriorated.

Up to this point, the dependent variable of this analysis was referred to obliquely as the "character" of dyadic interaction in the international system. We are able to intuit that one dyad has a better character of interaction than another. For example, Belgium and the Netherlands cordially interact; Iran and the US have unpleasant relations. However, to create a quantitative forecast, intuition is not sufficient. Instead, we need an operationalized dependent variable that can help to tell us when our model accurately explains the character of a dyadic interaction. Again, see Box 2. The occurrence of armed conflict that leads to battle deaths between sovereign states serves as the operationalized dependent variable in this project. I use this as my calibration tool both conceptually and empirically in order to create indices that represent the character of state interaction across time. The occurrence of armed conflict between two states unambiguously identifies the full deterioration of the character of dyadic interaction.. It represents one extreme of a quantified index that gets at something that is difficult to otherwise operationalize. The second half of Chapter 2 provides an overview of this variable by exploring how international conflict has been empirically and theoretically treated in IR.

At the end of Chapter 2 readers will have a good understanding about the kinds of things that we can reasonably say in forecasts and how this is related to the operationalized dependent variable used in this project. However, getting from this understanding to a long-term integrated forecast is no simple task. Chapter 3 lays the next block in this dissertation’s foundation by providing readers with an overview of literature and methods related to theoretical and applied approaches to working with complex systems.Long-term integrated assessment forecasts rely on the interaction of variables both across and within a wide range of key global systems. These approaches leverage both conceptual and applied systems theory. Chapter 3 introduces conceptual systems thinking, focusing on system interaction, characteristics and delineation. This theory forms the basis for making practical modeling decisions, referred to as applied systems thinking. Applied systems approaches—often using systems dynamics methods—form the backbone of our forecast tool. Chapter 3 ends by generally introducing the IFs model structure, developed primarily by Barry B. Hughes over the past three decades and now housed in the Frederick S. Pardee Center for International Futures.

Chapter 4 turns from issues of forecasting to our understanding of state behavior in the international system. Here I evaluate the key and generalized arguments within the field of IR (See Box 1). I focus on Realism, Liberalism and their critics and place special emphasis on how these measures have been traditionally operationalized. Both substantive fields in IR are broad in scope, and my account in Chapter 4 is not meant to fully capture the breadth of either field. Instead, here I am interested in laying out approaches to understanding state behavior and what kinds of variables have historically been leveraged to quantify these theories.

I attempt to extend this analysis. I do this by "pulling threads" from critical perspectives of rationalist accounts in general, and Liberalism and Realism in particular. I argue in Chapter 4 that both standard bearers of IR have been criticized for being excessively parsimonious, poorly treating complex networks of relationships and not giving full shrift to the importance of interdependently created norms and values. I am interested in explaining cultural understanding between states using Katzenstein's definition of norms: "collective expectations for the proper behavior of

Box 3: Distinguishing CoI Index from Liberal Index:

Countries can have high CoI Index scores but low Liberal scores, and vice versa (Chapter 5). Historically, countries with high CoI Index scores and low levels of Kantian Liberalism existed throughout the Middle East and North Africa and in the former Soviet Bloc during the Cold War. Countries with low CoI Index scores and high levels of Liberalism exist currently in dyads that are small and physically distant, like Mongolia and Luxembourg. There has been a convergence between the CoI Index and Liberalism across time.

actors within a given identity" (1996, 5). I used these criticisms to build a quantified measure that explains some of the characteristics highlighted by these critical perspectives. This third measure in my dissertation is referred to as the "Cultures of Interaction Index" (CoI Index) and it is created using a dyad-first operationalization itself constructed from five sub-indices that captures complex networks and tries to draw out an understanding of culturally driven interactions between states at a dyadic basis (See Box 3).

Quantifying theory—the job of Chapter 5—is useful but also deeply problematic. It is useful because, when a theorist sits down and translates an analytical framework into a quantitative index, she is forced to evaluate extant data (or create her own) and make clear-cut assumptions about how her concept can be transferred into numbers. This reduces hand waving and promotes transparency for the purpose of comparison and evaluation. There are infinite ways to operationalize either Realism or Liberalism. My approach to solving this potentially debilitating issue is to evaluate my quantification standards using the following criteria. First, has this approach to operationalization been used by others (in at least general terms) in academic literature? Second, can this operationalized index be formalized and modeled within an integrated assessment tool like IFs? Third, is there a straightforward way that I can build upon previous operationalization while retaining the second criteria? I make theoretical and applied contributions to the field by producing new data and quantifying both accounts using methods that are novel. Quantifying theory is problematic because it can be overly restrictive, and reduce the nuance and character of questions asked by a substantive approach or method.

After building the two standard-bearer accounts in IR, I turn to the alternative approach outlined in Chapter 4, the CoI Index. Here my goal is not to create a measure that can currently be forecast within the IFs system—it is hard enough to forecast Liberalism and Realism, let alone to construct a new approach out of whole-cloth and forecast it as well. Instead, my goal here is to create a historic data series that can be used as a tool for statistical analysis and as an initializing value in my forecast exercise. The CoI Index largely builds upon previous operationalization of Liberalism and Realism, and should be seen as a quantified compliment to those approaches instead of a refutation. As this measure cannot be forecast, it is the core of my uncertainty going forward (See Box 4).

Box 4: Can we Forecast Culture?

Chapter 2 argues that forecasted variables need well understood *stocks* and *flows*. Culture can act as a stock across time—we can measure it based on a public opinion poll of values, or by using other proximate measures. However, understanding its flow is much more difficult, and it appears to be discrete: whether Saudi Arabia and Iran move from a conflictual culture to a cooperative one is contingent on drivers of behavior well outside the scope of this analysis. Thus, the CoI Index remains an exogenous component of this forecasting project.

The final section of Chapter 5 evaluates a claim that has been tacit throughout this introduction: IR produces a series of tools that are more useful when used in an integrated analysis than when taken as separate explanations for behavior in the international system. I evaluate this by taking my three indices—the Realist, Liberal and CoI—and creating a series of logistic regression models that are fit to the historic occurrence of conflict (measured in various ways). Here I find that an approach that simply adds up the three indices produces a stronger fit to the historic data than any of the approaches in isolation. This both validates my contribution in adding the CoI Index to this analysis as well as my later use of the Integrated IR Index (the addition of Realism, Liberalism and CoI Index scores) to produce analysis on the future of state behavior.

With my historic analysis completed, I turn to the Base Case behavior of IFs in Chapter 6 (See Box 5). I operationalize my analysis by using the same Liberal and Realist measures that I created and analyzed in Chapter 5. I initialize each dyad's score with the 2001 CoI Index score (the most recent historic data available) and keep this flat across my time horizon (2050). The Realism and Liberal indices vary and form the core of my analysis.[2] I find that, on the whole, the character of dyadic interactions is improving, though serious problems persist. I then explore some of these most dangerous dyads—including China – US and China – India. I end this chapter by going on a global tour of regional powers and the forecast Integrated IR Index. This analytical exercise highlights the scale of applicability of the tool created in this project, which only begins to scratch the surface of possible utility.

Box 5: What is the Base Case of IFs?

The Base Case is a scenario produced within the IFs model that continues policy choices, technological advances, economic decisions, and natural system behavior similarly to its behavior since the end of the Cold War. This scenario does not include radical change and generally forecasts improving human development.

[2] Each dyad's Integrated IR score forecast is initialized using 2010 values for Liberalism, Realism and the CoI Index. The CoI index remains constant across the time horizon. Both Liberalism and Realism change across time and the CoI index remains the large scenario oriented uncertainty (in other words, if a dyad experiences a deterioration across time we can talk about how much an increase in the CoI Index would need to compensate for this deterioration).

The inability to forecast the CoI Index is another reason why standard Liberalism is not operationalized *initially* on a dyadic basis. Forecasting dyadic relations—such as trade—from the ground up is beyond current capabilities in a large-scale, long-term model.

Base Case behavior considers the impact of Liberalism, Realism and an initial condition that attempts to explain the culture of interaction between a pair of states. Because these forecast variables are themselves comprised of sub-measures, and each of these sub-measures is deeply endogenized within the IFs system, they already consider impacts from structural shifts in the international system. However, the treatment of structural shifts within IFs does not directly connect to changes in the character of bilateral interaction. In other words, the structural shifts—such as running out of fossil fuels—will impact economic variables and thus relative power, but they will not directly drive state behavior in the model that I created.

I extend the analysis of Chapter 6 by evaluating the potential impact on the character of state interaction of three structural transitions on the global horizon in Chapter 7. First, as many countries with low levels of fossil fuel reserves begin to run out, a relatively larger amount of production will shift to countries with extensive reserves. This has the potential to impact dyadic relations between these countries andGreat Powers trying to keep global markets churning. Second, the increasing pressure put on freshwater systems from agricultural production and population growth for dyads that share a river basin may have dramatic impacts on vulnerable dyads. Third, I measure the disruptive power of state instability in politically relevant dyads using an index-approach to analyzing vulnerability to domestic conflict.

This analysis identifies new hot-spots not identified in Chapter 6 that should be relevant to policy planners and analysts. An example of this output is shown below in a word cloud. The countries in this visualization are those who have quantified overall indices[3] that deteriorate over time, indicating that improvements in interdependence (Liberalism) are outstripped by deteriorations in other drivers. The size of the country name in the visualization below correlates to the number of deteriorated dyadic relationships forecast over the next four decades. As a point of reference, Iraq and Mauritania are forecast to have 10 dyadic relations that reduce in character.

Word Cloud of Dyads with Deteriorated Total Scores between 2010 and 2050

I draw the following conclusions from this dissertation. They are likely relevant to forward thinking policy analysts:

- Gains in Classical Liberal drivers—trade, democracy and embeddedness in international political systems—are forecast to improve state relations across the great majority of dyads

[3] The fully quantified index, explored in Chapter 7, contains the following: fully endogenized Realist, Liberal, Fossil Fuel, State Fragility and Water indices and an exogenous CoI value that stays flat across the forecast horizon pegged to 2001 values.

- Pressures from relative material power are forecast to have destabilizing impacts on Great Powers relations in spite of gains made by Liberalism: China – India, China – US and India – US
- Stabilizing interventions brought about by state fragility are forecast to be less common, though some states remain concerns over the next four decades: Somalia, Democratic Republic of Congo, Afghanistan, Chad and Myanmar
- Fossil fuel production is forecast to become increasingly concentrated (mostly in OPEC countries) and will continue to remain a key for Great Power planning even as the world moves towards greater renewable energy production
- Water resources are forecast to become more constrained in key river basins (North-East Africa, Middle East, Central Asia), leading to the possibility of deteriorated relations among states in these regions
- The following states experience a confluence of pressures that do not outstrip gains from Liberalism, and should be of general concern: Iraq, Mauritania, China, Iran, Sudan, Afghanistan and Kyrgyzstan
- Central Asia remains a serious concern for deteriorated interstate relations driven by low levels of growth in Liberalism coupled with the rapid rise of Turkmenistan (and their increased importance as a gas exporter), pressure from water stress and slow improvement in state fragility

This dissertation is one stage in a broader project designed to model IR and forecast the character of state relations. It is a tool building exercise, and more tools need to be developed to finally accomplish this ambitious task. I have created new data and structures that will form the basis of projects going forward that attempt to further evaluate how states have interacted in the global system. Future work should address broader networks of alliances internationally, take more care to treat regional power distribution to identify politically relevant dyads, and conceptually hone quantified indicators that can more effectively identify culturally relevant interactions between pairs of states.

2. The Future and Conflict

"We shall see strange things before we die. Dare we guess at what they will be?"
-Abramo Fimo Kenneth Organski[4]

"This volume is about war—that single collectively organized human effort which has taken more human lives than any other"
-Manus Midlarsky[5]

"History usually makes a mockery of our hopes and our expectations"
-Robert Jervis[6]

Introduction

Humans are stuck in the present but constantly moving through time. Because we (generally) desire to make a better life for ourselves and community, the constant tick-tick-tick of existence compels plan us to for what lurks around the corner. However, what lies ahead is fundamentally unknowable. We are stuck with the *problem of the future*: we are compelled to plan for it (and take action based on those plans) but we are unable to know what it holds (and thus unable to know if the decision we are taking is the right one).

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[4] (Organski 1958, 433)

[5] (Midlarsky 1975, xvii)

[6] (Jervis 1991, 39)

Our understanding of the past and present informs our understanding of the future, though all three time-spaces are fraught with epistemological complexity and uncertainty. The past is filtered through the subjectivities of the many who tell its stories and the traces of evidence that remain in the present. The present is complicated by the number of interacting variables and complexities occurring at any given point and the limitation of being one subjectivity occupying only a very limited terrain. The future is shrouded in a veil of uncertainty.

We are tied to a need to understanding the future, and the first section of this chapter sets a framework for thinking about what we can and cannot know. We act as if we know things about the future in the same way that we act as if we know the past. We have no absolute reason to believe that either fully corresponds to "reality". We are forced to make decisions about what is salient, more plausible and to learn from our mistakes along the way.[7]

Putting forward an epistemology of the future[8] sets the path for understanding the kinds of things that we can say about conflict over a 40 year time horizon. This is the goal of the second half of this chapter. This project cannot forecast when two countries will go to war over the next 40 years; that is beyond all human knowledge. However, informed by IR scholarship, we can analyze and assess the relative pressures acting on a dyadic relationship in the international system. Chapter 3 builds on this by presenting a

[7] This approach to decision making is partially argued for by Sharon Welch (2000).

[8] This section of Chapter 2 does not more broadly engage in debates about epistemology. Instead, the purpose of this chapter is to bring people up to speed on the kinds of variables that we can forecast over long time horizons.

theoretical and applied systems framework for understanding these questions, along with an introduction of the specific modeling technique.

Humans have a long history of trying to explain war. This has led to studies, theories, and findings on the subject. These previous works are useful, and form a block in the foundation of this project. However, as long-term forecasting is constrained by methods, technologies and epistemology, expectations about the scope and scale of what can be said reasonably about the future of war needs to be established.

Epistemology of the Future

We know absolutely nothing about the future because it has not occurred. The events of the next decade, day or minute are not knowable in any absolute sense. That said, there is reasonable evidence to assume that many currently observed phenomena will continue tomorrow, and for some time. In fact, we live our lives *as if* there is much continuity between the past, present and future.

This section introduces characteristics related to the type of variable that we are interested in forecasting over long time horizons (See Box 6). First, it must be a continuous trend, or at least a trend that can be understood in continuous terms. Second, the variable must have well understood stocks and flows that can be quantified. Stocks are the foundation of forecasting: they are accumulations of things that remain relatively consistent across time periods, such as population or capital. Flows take away

Box 6: What do we want to forecast?

This chapter will argue that the variables that we are most interested in forecasting are those where we can reasonably measure both continuity and change. Forecasting things like a sunrise is uninteresting because we only understand continuity and not change in its behavior. Forecasting population is interesting because we understand both continuity in the trend as well as change.

or add to stocks in any given period of time. Finally, the system in which the dependent variable is situated must be understood well enough to be able to forecast both continuity and change. We cannot forecast discrete events. However, we can use conceptually well understood continuous trends to measure the probability of the occurrence of a discrete event, related to our understanding of its historic occurrence. We also are not interested in forecasting trends where the underlying stocks and flows are not understood. In these variables—things like the force of gravity or the sunrise—we can understand continuity, but have no ability to measure change. All of this is outlined in more detail below.

The past tells us that there are things that we have been able to successfully know about the future and other things that have evaded human foresight. It is important to distinguish between different types of dependent variables and what we can know about their behavior. To begin this exploratory process, I present a taxonomy that distinguishes the degree to which variables have been accurately forecasted on one axis and our understanding of causality[9] related to their forecast on the other axis. The variables identified in Figure 2 should be understood as descriptive categories. This section should be seen as a compliment to Chapter 3 which fleshes out the concepts discussed here in a systems framework.

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[9] The treatment of causality in this section ignores the obvious problems associated with the term. Causal relationships are difficult to understand—especially in the study of war—and our understandings of causality should be tempered with great humility.

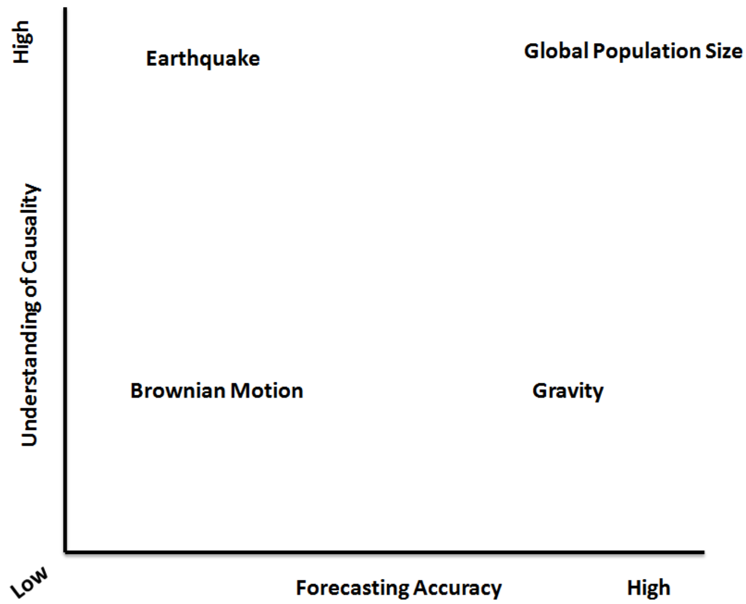

Figure 1: Epistemology of the Future

Starting in the bottom left of Figure 2, humans are unable to forecast the specific movement of particles that results from being bombarded by atoms—Brownian Motion—and we have no understanding of the causal mechanisms that drive its behavior (in fact, the longitudinal trend of Brownian Motion is a synonym for randomness). On the other end of this cross-cutting axis we have World Population which we have forecast both continuity and change with high levels of accuracy and whose causal mechanisms we understand clearly. The alternative cross-cutting axis describes a different set of dependent variables. Gravity is in the bottom right of Figure 2, the force of attraction between objects with mass. We have been very accurate in our historical forecast of Gravity (so accurate that many would not even claim it to be a forecast), however we do not understand its deeper causal mechanisms. Many physical "constants" or "laws" fall into this category. The top left category—an Earthquake—is a category where we understand the causal mechanisms that behave on the relationship, but have little ability to forecast it accurately.

Figure 2 draws attention to the distinction between forecasting continuity and forecasting change. In the top right we have a good understanding of forecasting both continuity and change in these dependent variables: we understand when population systems grow, when they peak and when they decline. On the bottom right we have the ability to forecast continuity, but not change. There is no mechanism—either theoretical or applied—for understanding if and how the forces of gravity will change from one year to the next. We rely on the assumption that, because they haven't changed, they won't change.

The difference between continuous trends and discrete events is also identified in Figure 2. First, continuous trends are those that can be measured (at least perceived) and have a clear trajectory across time. These events—like the average change in temperature across seasons in a given year—have cyclical behavior that produces patterns. Discrete events are defined as those that occur independently of driving variables,[10] such as the occurrence of a violent conflict between parties, the occurrence of a natural disaster or an unexpected interpersonal gesture. An Earthquake and the drivers of Brownian Motion are two events that appear to be discrete when they occur. The force of Gravity and World Population appear to be continuous trends.

The difference between a continuous trend and a discrete event hinges on two concepts: the treatment of time and our measurement of causal mechanisms. The

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[10] There are actually no discrete events in the world, as this would require a fully closed system with no drivers. Events *appear* to be discrete at times when we do not understand the causal logic. When discrete events are referred to in this project it should be understood to be referring to apparently discrete events.

treatment of time is one way to distinguish the top right and top left of the diagram, above, though it is also relevant for our understanding of the bottom two dependent variables. Most dependent variables are discrete at extremely long time horizons. Take global population as an example. If the time horizon is the last 200 year, or so, the trend appears to be continuous. This is not the case if the trend is taken over a much longer time horizon. Figure 3 shows global human population with a multiple billion year time horizon. At this level of distance, human population appears to be a discrete event. In terms of our diagram above, it would fall into the upper left category, as we have a good understanding of the causal mechanisms that are at play for the advent and growth of human civilization (evolution from more primitive organizes, organization into families and societies, the advent of farming, cities, etc.) but would have a nearly impossible time forecasting when this event would have occurred over the course of known history.

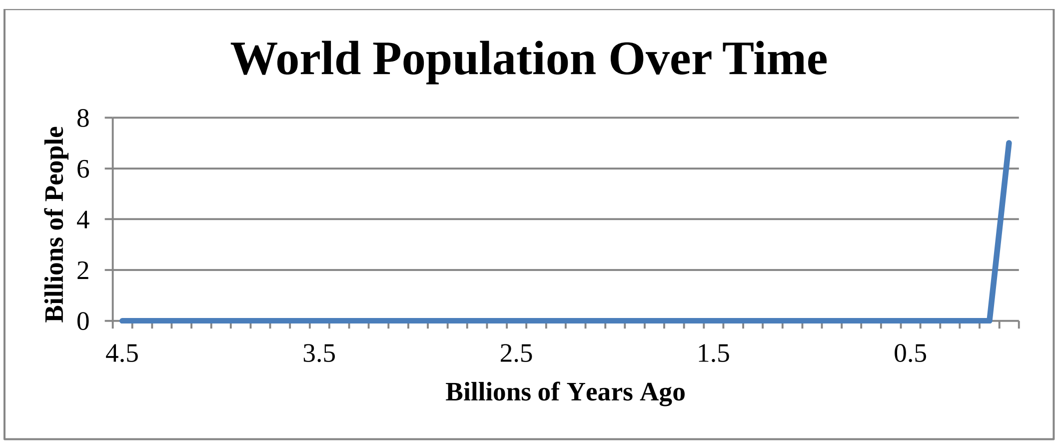

Figure 2: Global Population - Long Time Horizon

If our time horizon is extremely short, even an earthquake can appear to be a continuous event. If our perception of time was shortened to Planck Time (the time required for light to travel 1.616199×10^{-35} meters in a vacuum) an earthquake would gradually increase in strength, plateau and decline. It would appear to be a continuous event. However, because our filter is the human mind, generally accepted perceptions of time should be the reference point used to assess whether we have the ability to forecast dependent variables, and an Earthquake and Global Population stand at opposite ends of this spectrum.

The second distinction between discrete and continuous events relies on our ability to understand and operationalize conceptual variables. We have a good understanding of what causes earthquakes. Shifts in tectonic plates along well established fault lines produce massive amounts of friction and vibrations that shift the earth's crust. However, we are both limited in our deeper understanding of the drivers of earthquakes and our ability to operationalize key variables. The exact reason that plates shifts is not fully known, and could be due to changes in electromagnetic fields, pressures deep within the earth or long-standing movements that have been building pressure for thousands of years. Additionally, our ability to measure the exact amount of pressure between plates, the composition of the earth in areas most vulnerable, and the broader impacts from shifting plates on the other side of the world is impossible to operationalize. In other words, we do not have a global model of tectonic plates and geography that is sufficiently complex to capture the necessary effects to deal with accurate prediction of an earthquake.

We can understand and forecast global population levels with much more accuracy than we can the occurrence of an earthquake because we both understand the causality in population systems and are also able to operationalize key variables effectively. Population growth and change is contingent on well understood driving mechanisms. At its most basic on a global level it is directly driven by two variables: fertility and mortality rates. Fertility rates are driven by income, contraception use, infant mortality and female education. Mortality rates are driven by levels of income, technology and the prevalence of certain types of diseases.

This moves us to an important component of variables that we can forecast well and that we understand causally: stocks and flows. These concepts are treated in more detail in Chapter 3, but I introduce them now. To forecast continuity and change in a variable with accuracy—especially over a long time horizon—it is important to have a continuous dependent variable with well understood stocks and flows. In population systems, the stock from year to year is the overall number of people who are alive. Globally, there are two flows: births and deaths. First, as explained above, being able to operationalize these measurements is crucial. Second, the systems most easily forecasted are those with relationships where the stock remains fairly consistent for the time horizon in question and the flows do not change dramatically. See Figure 4 that traces the stock of global stock of population over time compared with the overall flow.

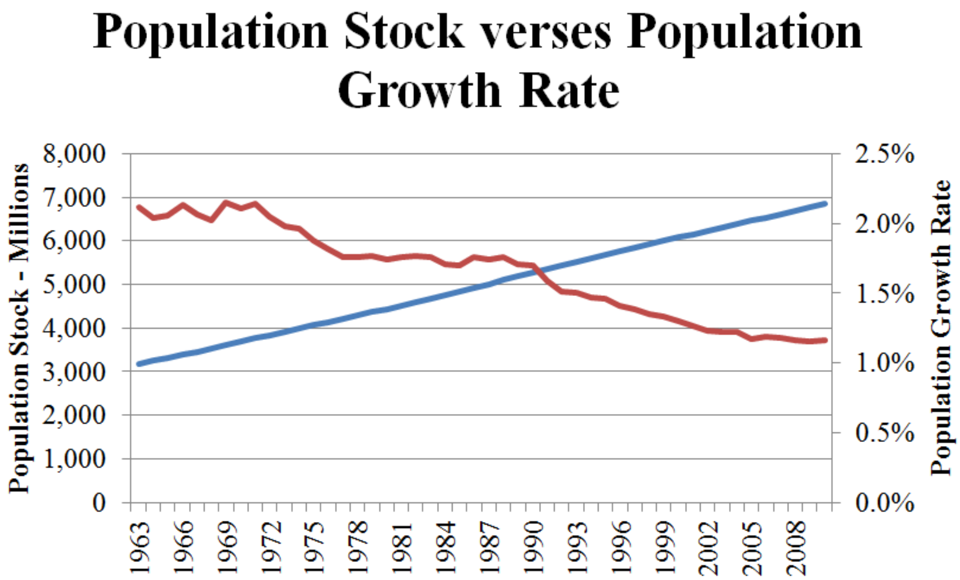

Figure 3: Population Stock verses Population Growth Rate

While I have used population systems as my example of variables that are accurately forecast and well understood conceptually, I could substitute the overall size of the economy as well. Global economic output (as measured by GDP and which is not a stock, but a flow) is similar to global population in that it is a continuous trend for a human oriented time horizons whose underlying components are well understood. Broken down, economies are made of three things: the overall stock of capital, the stock of labor and the stock of technology. We have clear measures of each of these three stocks, we understand why they grow and shrink year to year (the strength of the flows) and this allows us to talk about the long-term propensity for growth in an economy.

Economies are, however, different from population systems, in that their year-to-year growth projections are less smooth. Figure 5 shows the growth in global GDP over time as compared to the annual growth rate in global GDP. The growth rate over time experiences movement around a central trajectory (shifting from a moving average of nearly 4% down to a moving average closer to 3%), but these shifts are difficult to forecast over a long time horizon. GDP growth rates are typically forecast over a shorter time horizon (both the World Bank and International Monetary Fund forecast country-level GDP growth rates over three year time horizons).

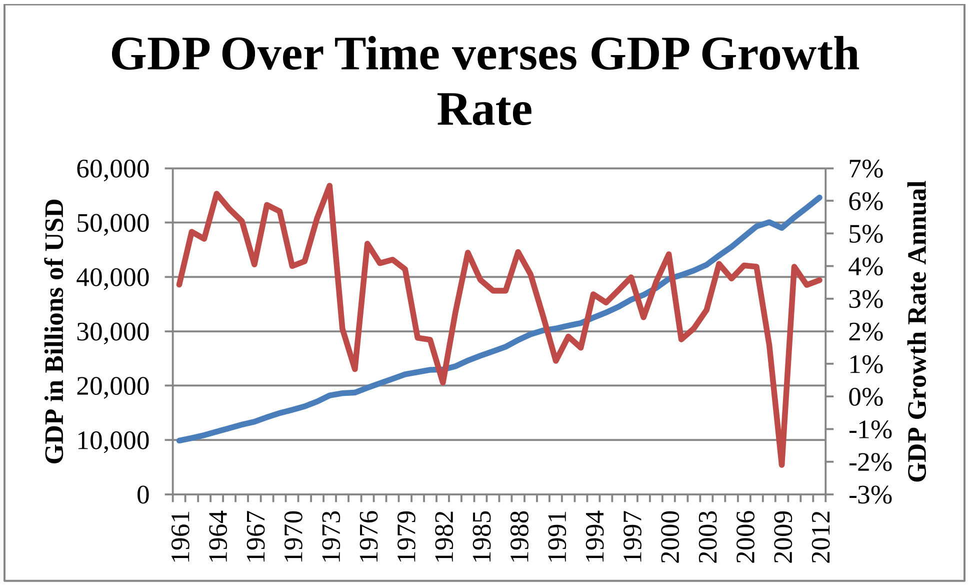

Figure 4: GDP verses GDP Growth Rate

The annual growth rate (the rate of change in the overall flow of GDP year to year) is forecast over a short time horizon effectively because it is driven by variables that we understand well but that change rapidly. For example, supply, demand and price are all components of short-term growth and these are all mediated through billions of individual subjectivities, which are less well understood (thus, things like "consumer confidence" and "market sentiment" become drivers of growth in short term models, but not long-term models). Government policy decisions—effectively discrete events that we understand causally (located in the top-left of Figure 2)—also have strong impacts on growth rates. The frequency and intensity of storms—something that certainly evades a long-term time horizon forecast—also impact GDP growth rates.

The focus of this project is international conflict, which is a discrete event similar to the occurrence of an earthquake. Like earthquake forecasts, forecasts of international conflict rely on measuring variables that are associated with the discrete event and that also have characteristics that are conducive to accurate long-term forecasts (well understood stocks and flows, continuous trend, etc). They thus become forecasts of the probability, or likelihood of the discrete event happening.

Probability is a measure of certainty related to the occurrence of a discrete event in a time-period. These measures can take various forms but two are particularly relevant to this project:

- the output of a model fit to the previous occurrence of the discrete event
- a conceptual index of variables associated with the discrete event

Both of these approaches are discussed in greater detail later in this dissertation.

This chapter takes this conceptualization of what we can say about the future and applies it to our understanding of international relations. The occurrence of war appears to be a discrete event whose causal mechanisms we fairly well understand. We have a hard time operationalizing some of these measures with long time horizons. I will use this framework to identify the specific dependent variable measured in this project. This then leads to Chapter 3 which provides a systems theory conceptual and practical framework to talk about how we model and how we produce long-term forecasts of continuous trends with well understood and operationalized causal mechanisms.

Treating War: Calibration Device

I am interested in quantifying the character of state interaction in the international system. Do states interact in ways that are agreeable or disobliging? A quantitative measure of this must be calibrated to some dependent variable that is not a part of the original index creation process (thus avoiding multicollinearity). This section introduces the operationalized variable that I use for this calibration: the occurrence of international war.

We intuitively know when states have better or worse relations. We know, for example, that the US has a better relationship with the UK than the US does with Cuba. In an ideal world this information would be easily quantified and validated for a large number of dyads. An operationalized measure like this could then form the backbone of the forecast analysis pursued in this project. However, information of this kind does not exist. Because of this I am forced to select an alternative measure that gets at some component of the character of dyadic interaction in the international system.

International war involves organized violence between states and results in the slaughter of humans. It generally occurs when the relationship between a dyad has fundamentally deteriorated, resulting in physical violence being the accepted vehicle for solving political disagreements. Dyads with cooperative patterns of interaction do not typically go to war, and examples are scarce across time relative to the total number of dyad-years.

This is the first reason that war is a fundamental part of this dissertation. I use it as a measure of dyadic relations that have clearly deteriorated. The "worst" scores in my Integrated IR Index should show the occurrence of conflict, while the "best" scores should correlate with non-conflict. War is also fundamentally important for this analysis because it is an operationalized series that is not used as a component of Realist, Liberal or CoI Indices. We cannot use levels of bilateral trade as a dependent variable to point to which dyads have better interaction because it is a sub-measure used in the creation of my indices. Similarly we can’t use embassies, treaties, IGOs or levels of democracy. As such, we need an “outside” variable to play the role of calibrator.

The second reason that war plays a key role in this analysis is that I am most concerned with which dyads are most likely to experience a future deterioration in the character of their interaction across time. I am less concerned with dyads that are likely to improve the character of their interaction, though the identification of this is a useful output of this project. My most obvious normative concern in this project is the avoidance of armed violence between states, and improving our ability to identify where conflict is likely on the horizon. This value is the second reason that an exploration of armed conflict is an important component to this analysis.

As the operationalization of war plays such an important role in this analysis, I feel compelled to treat the literature around it seriously. I use the remainder of Chapter 2—building upon the analysis done earlier—to argue for the specific kind of dependent variable that we want to use to determine whether states have better or worse relations.

War occurs when distinct political groups engage in armed violence in an attempt to resolve a disagreement. The above definition works conceptually, but is difficult to operationalize. For the purposes of measuring war’s occurrence, scholars and practitioners use definitions that emphasize battlefield fatalities. The threshold for conflict varies by the index in question (for Uppsala, it is 25 battle deaths over the life of the conflict, for Marshall, it is 500, and for the COW group, it is 1,000 (Gleditsch et al. 2002; M. Marshall 2003; Sarkees and Wayman 2010; Singer and Small 1994)).

These events are grouped by the kind of units engaged in violence: either domestic (civil war, for example) or international (between two sovereign states). The historic distribution of international conflict is different from the distribution of domestic conflict. Some examples from different data sets below help illustrate this. Overall, the stories told by the different operationalizations of conflict are the following:

- international conflict is a relatively rare event
- domestic conflict occurs more frequently than international conflict
- domestic conflict occurrences/magnitudes peaked at the end of the Cold War and have declined to levels seen closer to the middle of the 20th century

The first is the data on war compiled by the Uppsala Conflict Data Group (UCDG) in Sweden and displayed in Figure 6 (Eriksson and Wallensteen 2004; Gleditsch et al. 2002; Harbom, Högbladh, and Wallensteen 2006; Harbom and Wallensteen 2005). The number of conflicts has grown from a low point in the early 1950s of around 15 on an annual basis to a peak of over 50 during the turmoil at the end of the Cold War. After this peak, the overall number of conflicts decreased to less than 40 conflicts annually for most of the first decade of the 21st century.

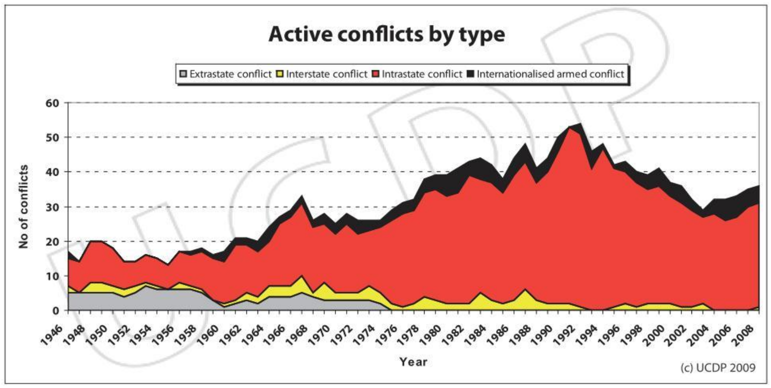

Figure 5: The UCDP Data (Eriksson and Wallensteen 2004; Gleditsch et al. 2002; Harbom, Högbladh, and Wallensteen 2006; Harbom and Wallensteen 2005)

Figure 6 also highlights the relative frequency of interstate conflicts to all other types of conflict since the end of WWII. There has also been great growth in intrastate conflicts over time, rising from less than 10 per year to almost 50. Interstate conflicts have been a relatively small portion of the overall conflict mix over time representing at most 5 incidences of conflict in a given year, and as few as zero.

The data in Figure 7 track a similar trend, and are compiled by Marshall at the Center for Systemic Peace (M. Marshall and Cole 2009; M. Marshall 2003). This graph measures the overall magnitude of conflict, and not the numbers of conflicts, as were being measured by the UCDG group above. In spite of the different dependent variables the two graphs show a similar trend: overall, conflict starts out at a relatively low level at the end of World War II, climbs to the end of the Cold War, and then eventually falls again, but not yet to the level experienced directly after 1945. The Center for Systemic Peace group and the UCDG group both show similar distributions in the breakdown between domestic and international conflict. “Societal Conflict”—domestic war—starts out at a very low level after WWII, grows quickly and consistently, and then falls sharply after the end of the Cold War. International conflict remains relatively low throughout the entire period.

Figure 6: Center for Systemic Peace Historic Conflict Data: Total Magnitude of Conflicts (M. Marshall and Cole 2009)

Figure 8 explores the Correlates of War Data (Singer and Small 1994; Singer 1972; Singer 1978; Sarkees and Schafer 2000) and was re-produced from data published by Sarkees, Wayman and Singer (2003). These numbers explore a longer time horizon than either the UCDG or Center for Systemic Peace data. It again compares international and domestic conflict, though this time does so in terms of the number of conflict onsets by decade. The occurrence of international conflicts peaked at the end of the 19th century, with 20 per decade. This distribution has since waned through the 20th century. Civil wars, on the other hand, show a different distribution entirely. The number of onsets fluctuated throughout the 19th century, and takes off after WWII.

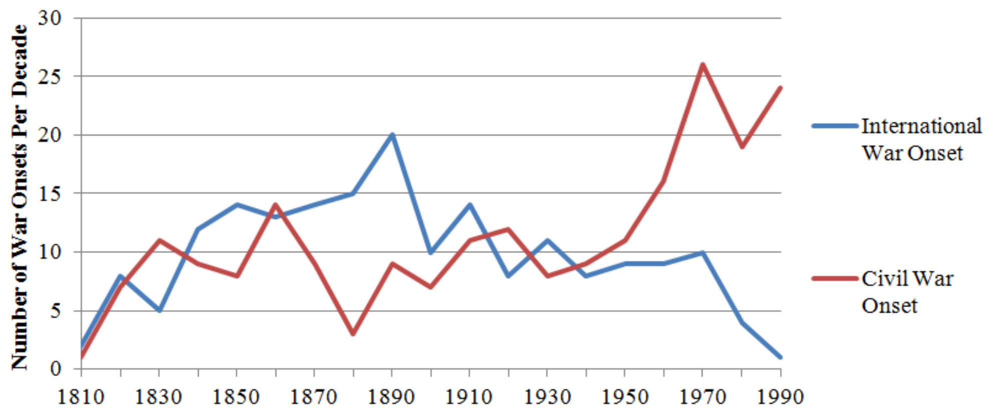

Figure 7: COW Data: Civil and International War (Sarkees, Frank Whelon Wayman, and Singer 2003)

Domestic conflicts have occurred more frequently than international conflicts. This has led to an increase in focus on these types of conflict in the academic and policy oriented literature, specifically since the end of the Cold War. This focus has been largely warranted, though scholars and practitioners should not neglect the occurrence of international disagreements as a key issue moving forward. As Chapter 1 indicated, while large-scale international conflict is on the decline and the relative frequency of small-scale international disagreement is also in retreat, the absolute number of Militarized Interstate Disputes continues to grow.

While the world has learned lessons from the destruction of previous large-scale conflicts, militarized disagreement between states continues. These disagreements often lead to confrontation that falls short of the traditional measure of 1,000 battle deaths. Militarized Interstate Disputes (MIDs) are used to operationalize these lower-threshold conflicts. This measure is defined as:

> "Militarized interstate disputes are united historical cases of conflict in which the threat, display or use of military force short of war by one member state is explicitly directed towards the government, official representatives, official forces, property, or territory of another state.

> Disputes are composed of incidents that range in intensity from threats to use force to actual combat short of war" (Jones, Bremer, and Singer 1996, 163)

The line graph below takes MIDs and measures them two ways: first, their absolute value across time and second as a percentage of the total states in the international system (Russett, Singer, and Small 1968; Singer 1980). This figure tells two stories about the development of international disagreement. The blue line measures the percentage of total possible dyads that are involved in a Militarized Interstate Dispute in any given year (using a 5 year moving average). Throughout the 19th century, around 1 percent of total possible dyads were involved in conflict. This measure spikes during World War I and World War II up to over 3.5 percent. It falls quickly at the end of World War II and continues to decline to the end of the time horizon. As of 2000 less than 0.5 percent of total possible dyads experienced international conflict. The probability of a state in the latter half of the 20th century engaging in a Militarized Interstate Dispute was lower than at any other point since the beginning of the 19th century. This is a positive development.

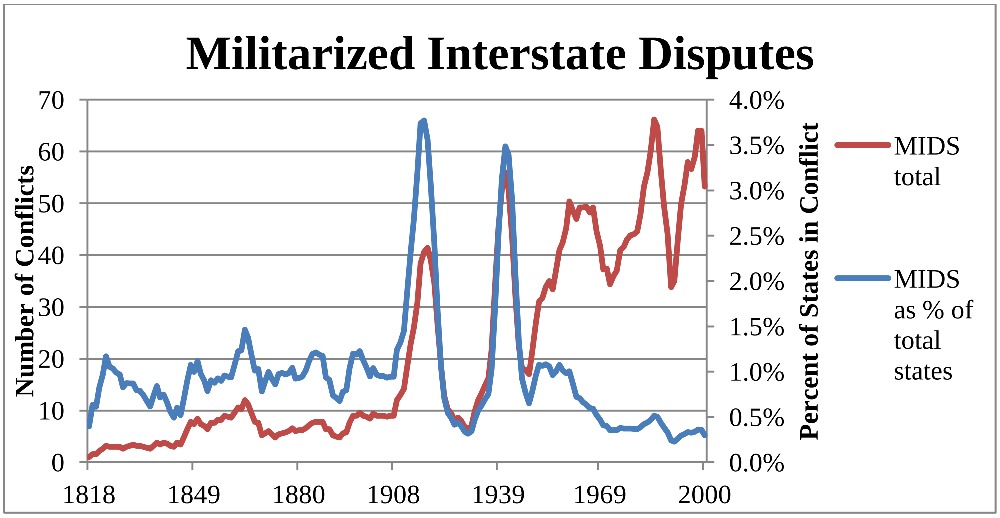

Figure 8: Militarized Interstate Dispute - 5 Year Moving Average, Measured Two Ways (Ghosn, Palmer, and Bremer 2004, 3; Jones, Bremer, and Singer 1996)

The red line tells a different story by measuring the absolute number of MIDs. It demonstrates relatively low levels of overall conflict in the 19th century with spikes during World War I and World War II, a similar story to the measure of percentage of dyads with conflict. However, the two accounts diverge in second half of the 20th century. Here decolonialism and the end of the Cold War birthed new states and new conflicts. These new countries offset the absolute jump in MIDs, making the increase in conflict difficult to see in the relative measure.

A state at the beginning of the 21st century could, on the one hand, consider itself lucky: the probability of involvement in a MID was lower than at any point in the previous two decades (not to mention there being an impressively small chance of involvement in a massively destructive war). On the other hand, a state might engage the international system warily: the absolute number of small international conflicts was on the incline. States continue to disagree, finding reasons to quibble, which can lead to small-scale military disputes. Even if dyadic tension does not rise to the level of violence, disagreements can weaken previously strong relationships and produce issues for foreign policy and diplomatic engagement.

This section of Chapter 2 explores the literature on international conflict. It builds a foundation that is linked back to the discussion at the beginning of this chapter. I argue that, if we are interested in modeling and forecasting international conflict, we need to hone in on a dependent variable that is conceptually well defined with a continuous historic trend and well understood stocks and flows.

This project forecasts vulnerability to international conflict in the same way that a seismologist forecasts an earthquake. Instead of trying to predict the occurrence of a discrete event, I measure continuous and conceptually well understood trends that are linked to the occurrence of international conflict and that are informed by IR theory. This allows me to create indices that measure the relative likelihood of international conflict occurring between two pairs of states. I begin by tracing fundamental concepts in the study of international conflict.

Fundamental Concept: Levels of Analysis

The "Levels of Analysis" debate informs theories that identify the causes of international conflict. This is important for this dissertation because I am drawing on theory that operates at the systemic level[11] but I eventually operationalize things entirely at the dyad level. I introduce this concept here to inform the kinds of things that we can say about the future of international conflict. Explanations for the causes of war take place at three levels: humans, the state and the international system (Waltz 1959).

[11] Structural Realism clearly is a system theory in IR, Wendt's Cultures of Anarchy is clearly at the system level and Cosmopolitanism is at the system level as well, among others.

Individual system theories—the most granular level of analysis—highlight drivers of international conflict that take place at the level of human decision maker. These explanations for the conditions for war deal with human nature, psychology, perception and personality. Much of the structure of this outline of human causes from war draws on Cashman (1993).

Human nature has been considered to be a driver of international conflict for some time. Authors like Hobbes, Spinoza and Freud all identified aggression and hostility as core components of human nature and behavior. These, it was thought, were the fundamental drivers of conflict between people. Extrapolated, these also became the core drivers of war. These are the necessary conditions for war.

Another group of theorists eschewed the rigid essentialism of discussions of human nature and instead focused on aspects of human emotion, personality and perceptions. Some, like Adorno, identified specific traits that made someone more likely to make dogmatic decisions, and thus predisposed some to be inflexible in problem solving, potentially leading to choices made that emphasized violence. Etheridge, for example, categorized personalities in the Johnson administration as being either introverted or extroverted. Those who were extroverted tended to prioritize inclusive policies towards the USSR compared to the more introverted (1978).

Misperception has also been explored by a variety of authors as a driver of international conflict (Jervis 1976; Levy 1983). By perceiving reality to be different than it is, leaders may make decisions that promote conflict by 1) believing that opponents are more belligerent than they are; 2) misunderstanding an adversary's level of material power; 3) believing that war is an inevitability; 4) expecting war to be short and not costly; 5) not understanding third party states' goals and desires; or 6) not understanding the other's worldview (Cashman 1993).

A third kind of explanation for drivers of war bridges individual systems and state systems. This group of theories focuses on how state decision making can be made by a kind of group-think mentality that drives misperceptions, thus leading to conflict. Janis, for example, argues that there was pervasive groupthink in the Kennedy administration, thus leading to the Bay of Pigs invasion (1982). Another kind of bridge between the psychic system and state systems is game theory, stimulus response theory and rationality. These approaches anthropomorphize the state into a rational actor who is (typically) interested in maximizing security.

In international conflict, states do not go to war by themselves; they always need a partner (though this partner may be unwilling). Thus, the second level of analysis—state systems—focuses on how domestic pressures and bi-lateral pressures can lead to war or peace. At this level of analysis, the most germane drivers of international conflict are relative to one state's position to another. Geographic continuity has been shown to be the main driver of international conflict, for example (Bennett and Stam 2004). Territorial disputes are one of the main drivers of international conflicts, and have been shown to be one of the main causes of conflicts over time (Jensen 1982). Many states have gone to war with a neighbor when this neighbor has shown high levels of instability and is itself weak. Blainey argues that, from 1815 to 1939, a full 15% of conflicts have occurred directly after a neighboring country has been engaged in civil conflict (1973). Others have argued that states have used intentional conflict as a way of mitigating negative implications of domestic instability (Rosecrance 1963). This "diversionary theory of conflict" has been shown to be a driver of US involvement in military activities during an election year (Ostrom and Job 1986). Maoz has found that there is a link between domestic revolutionary movements and international conflict. When states emerge from their own revolutions, they tend to be more heavily involved in international conflict (Maoz 1989).

Additionally, states can be differently constrained by their own government systems. States that are more pluralistic in their decision making, it is argued, have a harder time amassing troops for conflict. On the other hand, states that are autocratic may have a less difficult time urging young people to go into battle, as there is a monopoly on decision making. This explanation for war is dealt with in the section below, outlining the international system.

The international system does not go to war, but it is an important theoretical level of analysis related to the drivers of international conflict. Instead, of going to war, the international system is the context in which wars occur. The international system level is also a fundamental component of understanding the difference between Realist and Liberal accounts of conflict.

Realists argue that international conflict will always be with human beings—no matter how altruistic our intentions are—because the international system is not structured hierarchically. Stemming from Hobbes, these authors argue that hierarchically organized systems allow for the promotion of peace and stability because there is an authority that can establish peace through force. Since the international system is not itself structured hierarchically, states are forced to fend for themselves. These conditions create a self-help system and lead to distrust and violence.

On the other side of the coin, Liberals argue that the international system contains pieces of interdependence and norms that exist beyond the direct control of states. International agreements, though they are not made binding by an international hegemon, still change the cost of state-based decisions. When states agree to economic, political or other international treaties and agreements, they increase their interdependence with other states, thus bringing about a context where some decisions can be made on a level ideational plane.

Causes and Correlates of War

Suganami argues that there are three types of questions about the cause of war (1996). The first are questions concerned with the necessary conditions for war. The second are interested in the kinds of conditions that tend to be present when wars occur. The third are questions concerned with how a particular war came about at a particular point in time.

These questions highlight broad differences in our understanding of war. The first question focuses on the kinds of things that have to exist for war to take place, a kind of question interesting for philosophers. The third question concerns specific wars, the kind of thing germane to regional experts. This project is invested in building a model that highlights answers to the second question. This approach shapes the following conceptualizing of a model of international conflict.

The "kinds of conditions" that are frequently present when international conflicts occur are the causes or correlates of war. Specifically leveraging the work of the Correlates of War project (Singer 1972), this dissertation privileges an understanding of correlation over causation, or, in Suganami's words, an understanding of the "kinds of conditions" that are frequently present when war occurs (1996).

So, what then are the conditions that tend to be present when wars occur? Recent work by Bennett and Stam has quantitatively assessed the relative strength of different drivers of international conflict on the history of war (2004). It has found that, in the diagram below, the variables on the left decrease the likelihood of international conflict while the variables on the right increase the pressure for international conflict. They are organized by the relative strength of these variables impact, from stronger effect (on the top) to weaker (on the bottom).

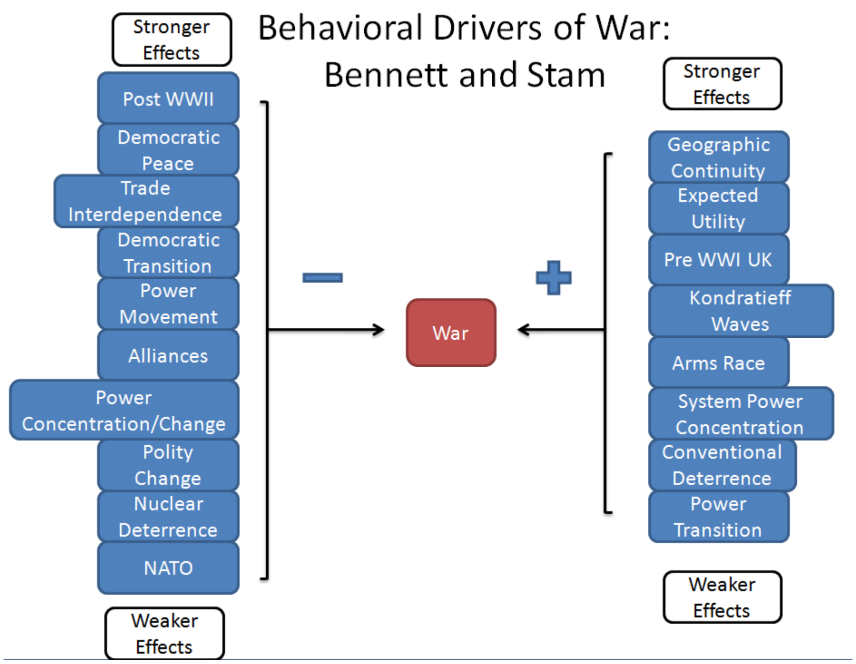

Figure 9: Probabilistic Drivers of War (Bennett and Stam 2004)

Drawing on lessons from the first section of this chapter, many of the variables in the diagram above can be useful for long term forecasting. In other words, they are variables where we can reasonably model both continuity and change across time. These types of variables mush have well understood stocks and flows. For example, any measure of material power—and thus drivers of both Power Transition theory and Balance of Power theory—rests on an understanding of military spending and growth in overall GDP. The deeper stocks of those measures are capital, labor and technology. It is impossible to forecast continuity and change over long-term time horizons for other variables in this list.

Take, for example, membership in NATO. Whether NATO is a relevant alliance grouping in 20 years is a difficult to ascertain because modeling change in that driving variable requires understanding the deeper drivers of membership and how these are likely to change. We simply do not have adequate information (either conceptually or quantitatively) to forecast continuity and change within this variable, and it thus becomes inadequate for thinking about the long-term behavior of states.

Bennett and Stam are just the latest in a long line of researchers who have quantitatively explored the conditions that are frequently present for the occurrence of war. These include Wright (1964), Singer (1972; 1978; 1994), Singer and Small (1994; 1966), Ray (1995; 1993), Diehl (1988; 1983; 1985) etc. While quantitative models are useful, the study of war suffers from a variety of problems that make them incomplete. First, wars happen very infrequently. This makes their statistical evaluation very difficult. For example, there are approximately 16,000 pairs of countries in any given year. However, the number of conflict pairs engaged in war is very small, somewhere in the range of 0-10 per year. Thus, approximately only 0.03% of all country pairs are involved in conflict in even the most violent of years.[12] This presents problems for statistical analysis.

War and the Future

Long-term forecasts of the occurrence of war can be conceptualized using the gas-and-rag metaphor. The rag represents a pair of countries. The amount of gas on the rag indicates the vulnerability that these countries have to conflict. This is the continuous trend with well understood stocks and flows that are measured in this project.
If a dyad has high levels of gas on their rag then they are more vulnerable to a spark causing a fire. Sparks are the wild-card events that take place at levels-of-analysis that are overly granular for this project (such as leadership decisions, the specific occurrence of mass movements, etc). We cannot forecast sparks, but we can measure continuity and change in the amount of gas on the rag over long time horizons.

The gas on the rag—the output of the project—is the likelihood that a pair of states will experience conflict in a given year. Likelihood—or probability—is a measure of our confidence in the outcome of an event and can be measured in various ways. Others—see the discussion of Bennett and Stam above (2004)—have created quantitative models with the historic occurrence of conflict that accurately fit a statistically significant probability to the occurrence of conflict. I do not replicate this work. Instead, I am interested in the likelihood of conflict as measured through a conceptual index.

Conceptual indices are useful for analyzing international or domestic conflict. The historic occurrence of conflict is a very rare (as a percentage of possible occurrences) and

[12] This is conflict defined by 1,000 battle field deaths, since 1960.

is driven by variables that significantly differ across cases. The characteristics of quantitative date related to international conflict can pollute results produced by probabilistic measures because the data do not conform to normal sampling, among other problems. Thus, an index measure of conflict can be a useful addition to pure statistically driven models. The distinction between using probabilistic and index models already exists in the field of measuring domestic fragility to conflict.

But measuring the amount of gas on the rag for any given dyad is contentious. IR theory tells us that there are competing accounts of the drivers of vulnerability to conflict, with Liberals and Realists standing largely in opposition. This project takes this division and works it into a framework for analysis. I operationalize these two IR theories and add a third built on standard criticisms of both Liberalism and Realism. I use these three operationalized IR theories to build an index of the dyad-year threat of international conflict between each pair of states in the international system.

This chapter has set one block in the foundation of the dissertation by presenting a framework for understanding what we can say about the future as well as introducing our understanding of international relations theory vis-à-vis war. Bringing these two threads together points to what I am modeling and analyzing. The dependent variable measured in this dissertation is the dyadic vulnerability to conflict operationalized through an index built from IR theory and forecast from 2010 to 2050 and it is a proxy for the character of state interaction (discussed in Chapter 1). I cut into this problem using state dyads as the level of analysis informed by the system level of analysis but rejecting the human system level of analysis.

3. Systems Theory and Modeling: From Concept to Integrated Application

"Every living organism is essentially an open system"
-Ludwig von Bertalanffy[13]

"The ability to predict outcomes in open systems is beyond all science"
-Colin Wight[14]

Introduction

Chapter 2 outlined a foundation for thinking critically about epistemological considerations associated with the long-term forecast of pressures associated with international conflict as a proxy for the character of dyadic interaction. There I concluded by highlighting what we can reasonably forecast over long time horizons: vulnerability towards international conflict using variables taken from IR theory with continuous trends, stocks, and flows. I used Chapter 2 to identify the dependent variable, but the method leveraged to produce results remains unspecified.

All theories are models and all models are representations of reality. Models are used in all aspects of life, both academic and applied. Models take an infinitely complex

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[13] (Bertalanffy 1968, 39)

[14] (Wight 2006, 52)

space (an open system) and prune it down into something that humans can work with (an apparently closed system).[15]

Different accounts of the causes of war rely on models. A Liberal model may look like this: increasing levels of bilateral trade and democracy will lead to regions where the threat of international conflict decreases. A Realist model may alternatively go something like this: global anarchy forces countries to focus on changes in relative material power, which can upset pacific relations and increase the pressure for war.

Formalizing a model requires following clearly defined steps. First, all of the crucial variables used in the model need to be outlined, typically in a schematic. Next, the key relationships between these variables need to be identified. Along with identifying the important relationships, it is crucial to establish the direction of the relationship: for example, does increased democracy increase or decrease the pressure for international conflict? If our model is sufficiently complex, we need to take into consideration how different modules within the broader model interact with one another. With a multi-layered quantitative model, putting numbers to all of the variables is not sufficient: one has to also be concerned with how the model behaves in different situations.

Understanding systems is helpful for building both of these models for the following reasons. First, when dealing with models that involve a large number of variables, systems thinking can act as a tool for organization. Second, when creating models where there is interaction between different sub-systems, systems thinking can help identify the expected behavior of interaction. Third, when dealing with large

[15] Open Systems are defined as the units that constantly interact with other units in a broader environment. Closed systems are defined as a select group of units interacting separate from an outside environment.

numbers of variables and complexity, a system approach helps to account for all activity within the model. Fourth, system approaches can create a framework in which models can be conveyed transparently.

Just as the first chapter set the foundation for thinking about forecasting, modeling and the long-range future of international conflict, this chapter sets the stage for the rest of the project by exploring the implications of system thinking on a model of international conflict. This chapter proceeds in three steps. First, it outlines previous attempts to use systems thinking and the theoretical foundations of the field. Next, it presents applied systems thinking, a requisite of actually formalizing our quantitative model. Finally, it uses these first two steps to build a modelling framework that can be used to plug in the theoretical approaches of IR for the purpose of long-range forecasting in a quantitative model by introducing the International Futures system.

Approaches to Thinking Systematically about Systems: Three Questions

"The systems theorist's orientation is to describe and predict complex elements and relationships in the real world...it has been easier to specify than to achieve"

-Arlyn J Melcher[16]

Saying that the work of science involves the use of systems is redundant. All science does systems, just like all science does models. While a focus on system thinking may at first appear non-descriptive, this is not the case. While all science uses systems, it does so in a wide variety of ways with varying degrees of commitment.

Generally, systems are "sets of elements standing in interaction" (Bertalanffy 1968, 38). However, when we typically talk about systems, we are referring to something with more distinct characteristics. Systems always have a boundary, and one main

[16] (Melcher 1975, 3)

consideration is the demarcation of that boundary. Systems are also comprised of units, which constitute the character of the system. The relationship of different units in a system is the system structure. One key question in the field of system thinking is the relationship between system unit and structure. Each system is embedded within other systems, either partially or fully.

Theories about system thinking have existed since the post WWII era. These approaches—most notably General Systems Theory (GST)—attempted to bring a more rigorous methodological approach to the treatment of systems to all areas of science. GST eventually became hypertrophic (Weltman 1973), overly focusing on the concept, and less focused on added value and practical application.

This section explores the three kinds of questions about systems referred to earlier: 1.) What are systems made of? 2.) What are typical system behaviors? 3.) How are systems delineated? This theoretical treatment of systems will then bridge to a more practical treatment of systems, eventually resulting in the full conceptualization of our forecast model.

System Components and their Interaction

Simple systems contain a boundary and elements within that boundary that have at least one conjoining characteristic. Complex systems increase the number of units within the boundary, compare interactions across boundaries, explore the correspondence across systems or inspect a system as it changes through time. This section begins with a simple understanding of systems, and builds in complexity, working through relevant arguments and literatures germane to the topic.

Waltz argued that the systems were composed of structures and interacting units (Keohane 1986, 70). This simple elucidation is reminiscent of von Bertalanffy's parsimonious definition of systems as "sets of elements standing in interaction" (Bertalanffy 1968, 38). Waltz stated that the definition of structure was separate from the characteristics of units. The key to understanding structure is to ignore *unit interaction* and instead focus on *unit position*. This “property of the system” is then built upon to argue that there are two main forms of political unit positioning: hierarchical and anarchical, with the former operating at a domestic level and the later at an international level.

Waltz’s understanding of system constitution is helpful, though misleading. It is true that, in the most abstract, systems are composed of units. The position that these units take vis-à-vis one another represents the structure of a system at any given point in time, another of Waltz’s points. However, the approach is misleading because it does not focus on the kind of unit or the type of unit interaction, but rather their relative position to one another. Unit type and interaction matter because they change the quality and character of the system structure.

This simple approach to understanding systems brings about two system components that have come to represent foundational theoretical decisions that must be taken at the occurrence of any system analysis: how much of a system is units and how much of a system is structure? Unit-emphasizing theory is typically referred to as agent-based analysis, or reductionist analysis. Structure-emphasizing theory is typically referred to as holism. Reductionists critique holists because they lack agency. Holists critique reductionists because they underemphasize (or entirely negate) structure. However, each theory can build up or down to take both agent and structure into account. This section will explore the agent-structure debate in full, but not yet.

Agent-based accounts that use a strong system method largely developed out of the cybernetic tradition (Wiener 1948). Cybernetics is an interdisciplinary approach to understanding the composition and character of systems building specifically out of mathematics and engineering, though used in other fields. The approach was applied in nature, and eventually built out to studies of artificial intelligence and agent-based modeling.

The agent-based modeling trend is most clearly seen within the school of thought that has come to be called Complexity Theory, and is most notably rooted within the Santa Fe Institute in New Mexico, USA. "Complexity theory involves the study of many actors and their interactions...a primary tool of complexity theory is computer simulation" (Axelrod 1997, 3). As argued by Phelan, Complexity Theory is neither General System Theory nor a series of postmodern "...metaphors or analogies based on resemblance thinking" (2001, 132). Instead, it is a, "...search for generative rules," that do not to seize the, "...radical holism of systems theory" (Phelan 2001, 130–1). The scientists engaged in these pursuits identify complex effects that stem from simple causes and try to map the regularities observed. The components of complex systems involve agents, strategy, measures of success, copying, population, type, variation, interaction patterns, artifacts, which all add up to the term "system" (Axelrod 1999, 4–6). The goal is not to try to overcome complexity, but to harness complexity (Axelrod 1999).

It is harder to pin down one group as a representation of the holist side of this debate. Some—like Luhmann—strip any standard understanding of agents out of his theory, instead arguing that the world is comprised of four main kinds of systems: mechanical, biological, social and psychic (1995, 2). The standard understanding of "agent"—as in a human acting within a system—becomes a combination of a psychic system (consciousness, psychology) coupled with an organic system (the body, brain). These systems then interact in social, organic and mechanical systems. Thus, if agency is understood to be action within a system, as per Archer (1982), for example, then there is still agency, as "human systems" still exist. However, this "agency" is not the same kind of agency explored within, for example, Complexity Theory.

Systems analyses highlighted here neither *build-up* a theory (e.g. agent-based modeling) nor *build-down* a theory (e.g. a fully structural model). These theories involve and explore the interaction of different system components. This middle-ground is most notably seen in the Agent-Structure debate.

This debate has spanned academic disciplines and time and is obviously germane to a discussion on the composition of systems. This debate, "…concerns how to develop an adequate theoretical account which deals simultaneously with men constituting society and the social formation of human agents" (Archer 1982, 455). Taken out of an anthropomorphic context, the disagreement was about trying to reconcile how units both shape and represent structure, and how structure is fully comprised of units, yet shapes units.

The discourse began fruitfully, but without a mechanism to move beyond pedantic claims about the cause of system change stemming *either* from agents *or* structures, it appeared still-born. Empirically, both agents and structures bring about important change in any system. A theory that took this into account needed to be developed.

In IR, Wendt's well known article brought this issue out into the open (1987). In this piece, he argues for the use of Giddens' “structurationist” approach (1984; 1979). In the words of Archer:

> “Giddens’ approach hinges on overcoming three dichotomies and it is these dualisms which he strips away from a variety of sources, then recombining their residues” (1982, 456).

First, Giddens views human action as being deeply embedded within actions in society, transcending the dichotomy between voluntarism and determinism. Second, he promotes the subject’s knowledgeability in her creation of society, while also keeping in mind that the subject is aware that they employ societal processes in this process, thus transcending the subject/object dualism. Third, Giddens rejects theories that separate static and dynamic treatments of time, thus transcending the synchrony/diachrony dualism. Structuration is mainly concerned with, “…amalgamating the two sides of each divide” (Archer 1982, 457).

This approach to solving the agent-structure problem was criticized by Doty, who argued that it did not go far enough and that agents were eventually underemphaisized and structures overemphasized (1997). Wight, another prolific writer about the agent-structure problem (2006), responded to Doty, arguing that she was searching for final solutions to an issue where none existed (1999).

Archer pushed this debate further afield by arguing for a “morphogenetic” approach that was distinct from the “structurationist” approach by promoting a final end: the reification of overall structure (1982; 1995).

> “’Morphogenesis’ is also a process, referring to the complex interchanges that produce change in a system’s given form, structure or state…, but it has an end-

> product, structural elaboration, which is quite different from Giddens's social system as merely a Visible pattern" (Archer 1982, 458).

The "morphogenetic" takes the attempted dynamism of the "structurationist" approach and gives it a telos. The "structurationist" approach understood the structure/agent interaction to be complex, and evolving over time. However, it did not identify a clear and concise way in that this interaction could move through time without appearing muddled. In other words, the "structurationist" approach understood complexity to end with complexity, and not to lead to something concrete.

Archer reconciled this by providing a clear time frame through which agent/structure, or in the language of Archer, action/structure, interact. In T1, structure exists independent of action. In T2, structure and Action interact. By T3, this has caused structure to become elaborated, which can be understood as the autopoietic moment within the system movement. By T4, structure again sits, elaborated, and independent of action (Archer 1982, 468).

In terms of system operation, many have argued that social systems are driven by agents, that these individuals are the "action" in Archer's construct. Luhmann, however, argues that it is not just individual action that is what drives system operation but rather *communication*. This is how social systems are able to reproduce themselves. Communication occurs through three ways: information, utterance and understanding (Seidl, Becker, and Luhmann 2005, 28). This communication must be understood *writ large*; it is the combination of all things that transfer information from one unit in the system to another. These communications produce specific *understandings* which then must be accepted or rejected by another unit in the system. Communication is similar to Bourdieu's *habitus* (1977).

Interaction across systems is different than interaction within systems. Luhmann is again helpful in this regard. Communication that occurs within a system is relatively smooth, as everyone is essentially speaking the same language. However, across systems communication is difficult.

“The living system is inaccessible to the psychic system; it must itch, hurt, or in some other way attract attention in order to stir another level of system formation—the consciousness of the psychic system into operation” (Luhmann 1995, 40).

System Characteristics

All system analysts identify system characteristics. This language has a certain kind of utility but has also contributed to hyperbole. It is important enough that I include an analysis of it here, but this project does not focus on generalizable system characteristics. I rather am interested in the specific kinds of characteristics that emerge from systems at any given point of time and dependent on their structure.

Some of the important nomenclature associated with General System Theory are, "...boundary, feedback, entropy, homeostasis, growth and decay and threshold," (Milburn, Negandhi, and Robey 1975, 11) along with, "...negentropy, equilibrium, and steady state..." (Wenninger 1975, 23). Complexity theory accounts for change in the world with the deployment of eight key concepts: fitness, coevolution, emergence, agent-based systems, self-organization, punctuated equilibrium, and fitness landscapes (Richards 2000; Lewin 1992; Kauffman 2000; Kauffman 1995; Kauffman 1993; Berardi

2009; Axelrod 1999; Axelrod 1997; Clemens 2002, 3). Each of these concepts deserves elaboration.

Table 1: Systems Characteristics: General Systems Theory verses Complexity Theory

System Characteristics: Definitions and Terms	
General Systems Theory	
Boundary	The line of demarcation that separates one system from another.
Feedback	Unit dynamic interacts with another unit in a system over time. Feedback occurs when, for example, increases in fertility increase the population, when then further increases total fertility.
Entropy	The loss of energy in any organic or mechanistic system as per the second law of thermodynamics.
Negentropy	The energy that a system expends to reduce entropy.
Homeostasis	How well a system can manipulate constitutive units to remain stable.
Growth	Increasing the amount of units in a system or the complexity of the relationship between units (through, for example, changing unit type)
Decay	Decreasing the amount of units in a system or the complexity of the relationship between units (through, for example, changing unit type)
Threshold	A place that is a boundary where a system goes from one state to another. Previous growth or decay rates change and new rates apply.
Fitness	The ability of a system to withstand change in its environment.
Complexity Theory	
Coevolution	The observed tendency where one system in close physical proximity to another system change in similar ways. The change in one system impacts other systems.
Emergence	Lower level complexity resulting in higher level complexity.
Agent-Based Systems	Systems that are created by the actions of agents, who create system characteristics that are associated with Complexity Theory.
Self-Organization	The units of a system independently and autonomously create and stabilize the system in question.
Punctuated	System changes happen when a threshold is passed, and do not

Equilibrium	progress linearly.
Autopoiesis	The ability of a system to reproduce itself.

The list above gives a taste of how different theories have tried to cut into complexity. Some themes appear. First, there is understandable overlap between different theories at different points in time: the General System Theory concept of homeostasis is relatively similar to the Complexity Theory concept of fitness; the General System Theory concept of threshold is also similar to the Complexity Theory concept of punctuated equilibrium. Differences are also noticeable. Complexity Theory is does not embrace the radical holism of General Systems Theory, and this leads to an agent-oriented emphasis (Phelan 2001). Characteristics of systems involve agent-based interaction and self-organization which results in emergent properties. General System Theory does not address ground-up emergence.

What is the utility of identifying a series of characteristics that seem to stretch across disciplines and time? First, it gives us something to look for: if we approach a new kind of complex system, we can see if we identify the characteristics and traits in the above list. Second, if we identify one of these characteristics in a system, we can use this as a point of reference to other systems. Third, some of these concepts are foundational and useful: complex systems involve feedback, have boundaries, sometimes grow and sometimes decay.

This focus on system characteristics may have been part of the reason that General System Theory did not survive as an academic discipline, and why, in my opinion, Complexity Theory is headed for a similar fate if it tries to be all things to all fields. It is odd to imagine that a list of system characteristics will be applicable across systems in a wide range of fields. What these approaches end up being reduced to is a set of labels that are arbitrarily slapped on characteristics in situations in which we already have perfect useful words.

A piece by Clemens is a good example (2002). In this, Clemens explores the issue of ethnic conflict in east Europe by applying concepts of Complexity Theory. He identifies four groupings of countries, and claims that one group in particular has developed with more stability for two reasons that stem from Complexity Theory: it has more fitness and it coevolved with Europe. Coevolution is a product of proximity, and social science has multiple ways of talking about things that are closer to each other impacting each other. The term coevolution adds nothing, and one word that would be a suitable substitute is *proximity*. The term fitness—and Clemens uses democratic institutions and open markets as a proxy for this—is argued to be a synonym for stability. If fitness means stable, why not use the word stable?

Complexity Theory has much to offer through the promotion of agent-based models, which provide novelty and potential understanding for how large groups of units interact and produce interesting results. The work of the Santa Fe Institute is a beacon for this kind of productive work. However, as a grab-bag of labels that can be slapped on system characteristics to sound sophisticated, it risks becoming irrelevant.

Trying to identify system characteristics that are applicable across academic disciplines may be a waste of time. Certainly, some system characteristics are quite useful—like growth and decay—but they are clearly not the sole purview of systems theory, nor are all systems always behaving in any of these ways. Systems theory should instead provide a framework for understanding and analyzing trends instead of attempting to create a model that all science can be wedged into.

System Delineation

Separating one system from its environment can be complicated. System delineation can happen in at least three ways: separating systems based on a measure of importance or influence, dividing systems hierarchically based on a metric of abstraction, such as into core/periphery or organizing systems based on the functions that they perform (Seidl, Becker, and Luhmann 2005, 36).

World Systems Theory and Hegemonic Stability/Transition Theory are two approaches to system delineation that divide states in terms of their relative influence. World Systems Theory—most notably proponed by Wallerstein—argues that the international system can be divided into core and periphery (and, in the case of some theoretical progeny, the semi-periphery) (1979). All important resources flow from the periphery to the core. These system components are distinguished not by function, but by influence.

Hegemonic Stability/Transition theory argues that there are qualitatively different kinds of states within the international system. When one state holds a preponderance of global power, it becomes the hegemon and is able to bring about stability within the broader system. This kind of system separation argues that different kinds of seemingly like systems can be distinguished based on their importance or influence.

International relations theory—especially Realist iterations—separates state systems based on their relative positions to one another, and not by their function or their influence. In other words, they separate systems based on what *kind* of system they are.

States are a certain kind of system that differs from an international system that differs from a psychic system. This is the ontological distinction highlighted by Buzan (1995, 203).

Waltz accomplished this by identifying the causes of war as emanating either from the system, state or individual (1959). The logic underlying this demarcation requires that one see different kinds of aggregations of units as representing different systems. For example, the international system is an organization of units that was particularly anarchic, and thus distinct from the hierarchy of states. Individuals were systems organized in altogether different ways, and in many ways (especially in accounts that reject classical Realism) fall mostly out of the analysis.

The system delineation identified by Waltz created a debate within IR theory on the different ways in which levels (read: systems) should be separated. As all state systems occupy a similar position vis-à-vis their (shared) environment, they are all treated similarly. This may underemphasize important sub-state characteristics that are germane for the IR theory (Singer 1961). Additionally, by lumping all "units" in the "international system" into one general category, much of the difference between unit interaction is missed. This, it is argued, can be overcome by focusing on how different states in the international system interact (Buzan 1995). Luhmann also separates systems based on their type. He divides the world into four systems: organic, mechanistic, psychic and social (Luhmann 1995).

The third method for delineating systems is based on what the system does. This approach—labeled by sociologists as "functional differentiation"—focuses on the kinds of tasks that are charged to different systems. Easton defines political systems as being,

“...oriented toward the authoritative allocation of values for a society” (Easton 1965, 50). Gilpin, drawing on Kindleberger, identifies the economic system and the political system by what they do: "...economics takes as its province the creation and distribution of wealth; politics is the realm of power"(Gilpin 1975, 22).

Though Luhmann breaks down general systems into four types—identified above—he is most interested in social systems. These kinds of system are separated from other kinds of systems because their method for reproduction involves communication. Within social systems writ large there exist myriad sub-systems, each of which is functionally differentiated.

Social systems are also broken down by type: society, interaction and organization (Seidl, Becker, and Luhmann 2005). Society encompasses all communication. Functionally differentiated social systems distinguish one from another by their “binary coding” (Seidl, Becker, and Luhmann 2005, 36). For example, the legal system is distinguished by communication that is understood as referring to the legal/illegal binary; economic systems the payment/non-payment binary, art the beautiful/ugly binary, etc.

The over-lap between different systems then depends on the kind of communication that happens at different points through time. For example, in buying a house, the legal system will transact the title based on understandings of legality; the economic system will be reified through the transaction of payment, etc. As systems are functionally differentiated, multiple systems can temporarily exist at the same time.
The point of system delineation—along with the point of systems theory in general—is to take complexity, break it down into manageable chunks, but to lose as little as we

imagine possible. If we can take our level of analysis—the globe—and break it down into large systems whose logic can apply broadly—across culture, space and hopefully time—then we are able to say something potentially useful about the whole.

Moving to an Applied Systems Approach

Applied system theory deploys core concepts that help to unpack the complexity of theoretical systems thinking for their eventual formalization and modeling. This is the bridge between the discussion in Chapter 2 and our eventual model output. These applied models start being built at around the same time as the introduction of General System Theory. They are closely associated with the development of computing power. With the ability to calculate much larger series of data than was possible before, researchers could formalize problems and tackle differently than previously. Some of the more notable system thinkers are Jay Forrester and Donella Meadows (Jay Wright Forrester 1971; Meadows, Randers, and Meadows 1992).

A foundational concept to understand in the study of system dynamics is the difference between stocks and flows, concepts that should be familiar to readers of Chapter 2. Building on that analysis, systems dynamics modeling help us to formalize assumptions in order to formally represent the kinds of variables that we can forecast over long time horizons. One basic example of a formalized systems dynamic model is demonstrated below. National stocks of population are understood as being directly driven by three independent variables. First, there is the flow of new people being added to the population. Second, there is the flow of people being removed from the population through death. Third, there is either an inflow or an outflow of people who migrate or emigrate. This is a simple demographic model.

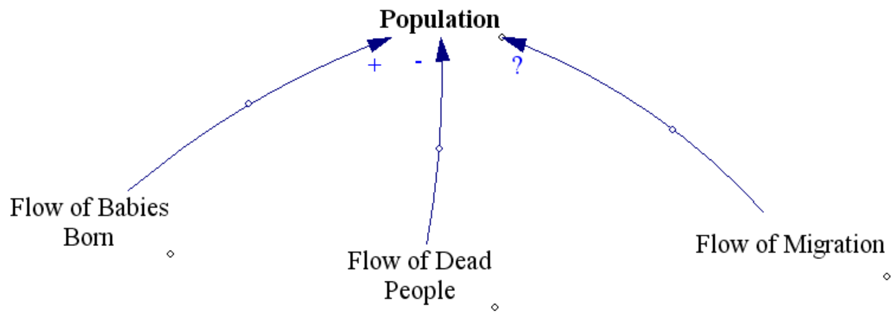

Figure 10: Simple Demographic System

These simple models can become complicated as feedback loops are added and time is taken into consideration. The model below highlights two of the three drivers of population growth, with their respective feedback loops. Thus, as more babies are born, the population grows. Higher population rates *ceteris paribus* then lead to higher births in the future. On the other side of the equation, when people die, they remove from the total population. As the size of the population shrinks, again, *ceteris paribus,* the amount of people who die will shrink as well.

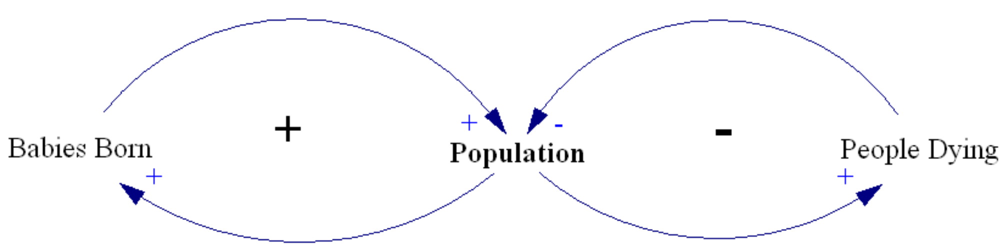

Figure 11: Dynamic Demographic System

This highlights some of the complexity involved in presenting issues in this simple format. In a general sense, yes, the above relationships do hold. However, when time is considered, along with dynamic trends—such as the education level impacting when and how many children families have—the picture becomes quicly complicated.

There is much happening in this simple diagram, and many variables that are not yet represented to fully represent a demographic system. The three variables are both independent and dependent variables. Depending on levels of births and deaths, population levels will eventually equilibrate at a measurable stock. There is much that is missing, and a full understanding of population growth would require an analysis of the deeper drivers of the proximate drivers of population, along with an understanding of how these different systems interact with one another.

This further and deeper understanding of demographic drivers is one of the things that an integrated assessment model like IFs attempts to accomplish. For example, look at this slightly more complicated causal diagram, showing the interaction of three systems, and building upon the previous analysis of the demographic system. If we start in the upper right, we see the positive feedback loop that we identified in the previous image between babies born (in this case, we're using the more technical term, the Total Fertility Rate, which is a measure of the total amount of children that one women will have in their lifetime) and total population. As more babies are born, the population increases, leading to more babies being born.

Now, let's look at the impact of one system on another system. In this instance, the size of the population has a direct impact on a variable in the economic system: the size of the labor force. For this example, let's assume that the economy needs more labor, though this would not obviously be the case in all countries. Higher labor then leads to higher levels of overall output (within the economy, the stocks are labor and capital, and the flow is output, typically measured as GDP). Higher levels of economic output have impacts on other systems as well. In this instance, we highlight their impact on the Education system, where higher economic output can help fund higher enrollment rates. Higher enrollment rates lead to more education, which eventually leads to a decrease in fertility rates and an increase in productivity.

With the arrows indicating the direction of the relationship between each of the variables in question, we can see that, as we drawn it, this system is a negative feedback loop. If time was taken out of the equation and the relationship between each of our parameters was identified, the total population after a number of model iterations would decrease. This is the decay feature discussed by General System Theory theorists.

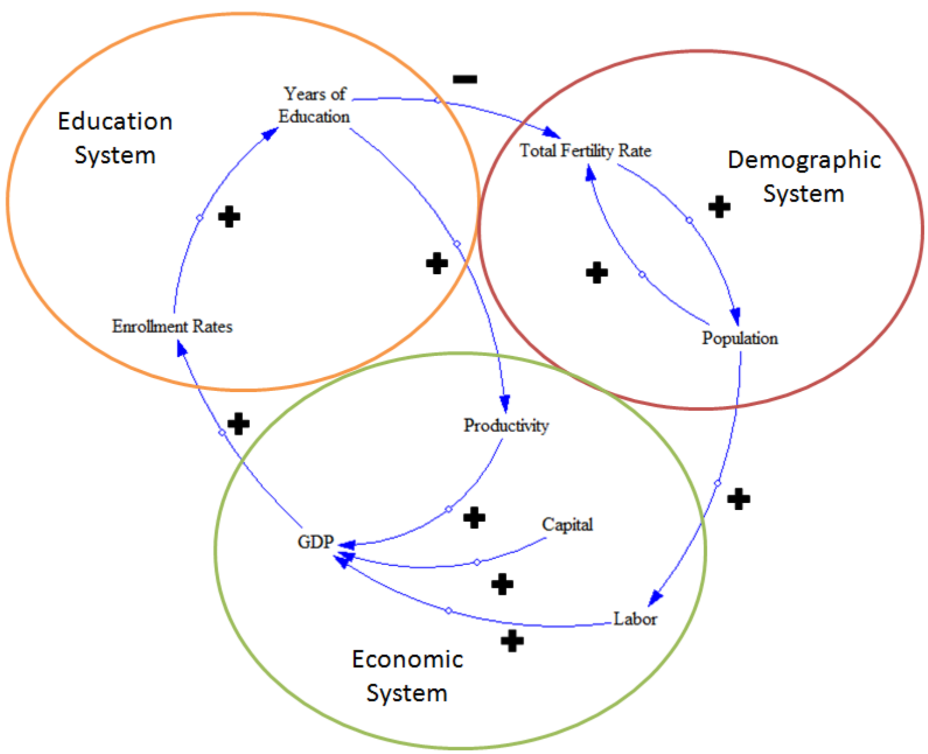

Figure 12: Dynamic Interaction of Multiple Systems

In the figure above, each sub-system is a different System Type. The Economic and Education sub-systems are both social systems that rely on the interactions of human agents working within Functionally Differentiated tasks. The Demographic System, on the other hand, is a natural system—though heavily influenced by social systems—that measure the amount of people who enter or leave a population.

Time Lags are a component of system analysis that helps to parse complex systems into more manageable chunks. In the example above, time was not taken into consideration, and the impact of population on fertility rates was assumed to happen immediately. This is obviously not the case. When fertility rates increase, more babies have been born. For this to increase levels of the population, at least 14 years and more likely 20 years have to pass. Taking time as an independent variable is crucial for the modeling of complex systems.

The Marginal Need of one variable as a component in the computation of another variable also was only tacitly referred to in the example above. In that example, I said that we should assume that the economy needs more labor, thus making the positive linkage between labor and GDP correct. However, the Marginal Need of GDP for *either* labor or capital will determine whether an increase in labor or capital will have a larger input on economic output. If an economic Structure—the relationships and kinds of units that comprise an economy—is already heavily endowed with capital, it will likely need more labor; an economic system that already has excesses of labor will likely need more productive power.

This leads to another point about trade-offs that can be inferred from the diagram above: because of limited resources, there is often—if not always—a Trade-Off in decision making. Enrollment rates were directly tied to economic output within the education sub-system. This connection is typically made through public investment in education, which then helps to attract students through improved quality and access to education. This government investment—like all investments in global systems—takes place amid various other choices. For example, governments must choose to invest in *either* education or the military, among other sectors that require funding.

Identifying that these kinds of choices exist within the analysis of complex systems brings us back to the agent-structure debate. To what degree do agents shape structures, and how do structures in turn shape agents? This is a fundamental aspect of understanding complexity in large systems, and further reveals the ability of humans to talk about these systems in the future.

It is difficult or impossible to forecast the impact of an individual on structure—the next Mugabe, Bush or Thatcher—because these impacts are discrete events. It is possible for individuals to change structure and future events, and this may obviously have long-term impacts. There are two responses to this: because these kinds of impacts cannot be mapped with current levels of technology—not to mention reasonably foreseen future levels of technology—people who use integrated assessment models do not use them. Second, it is also argued that the changes brought about by individual personalities and leaders are not as impacting on overall structure as some may seem to believe: the Second Iraq War, for example, while making large changes in a very short time, did less to alter long-term patterns of development within crucial systems like economics, demographics and energy. Much of structure is beyond the reach of single individuals.

That said the reach of large groups of people can more substantively shift the structure of a system. Actor behavior responds to a wide range of predictable independent variables. If the price of energy becomes dearer, individuals use less, and the price is driven down. If actors have higher levels of education, they make different decisions about fertility, for example.

Take the structure of savings and consumption in the United States as an example of the interaction between agents and structures in a system. In the 1990s and 2000s, agents in the US responded to an abundance of cheap credit by reducing savings and increasing consumption. Thus, the economic structure—promoted by low interest rates and limited regulation—shaped agent behavior. Agent behavior—responding to signals from the economic structure—spent widely and saved little. This behavior promoted financial speculative bubbles in various sectors, most notably within real estate. When the bubble reached a limit, the global economic system was altered. This interaction, well documented by Archer, is a fundamental aspect of the study of large systems in complex environments. Integrated assessment models do not necessarily track bubbles (though they can be useful in identifying them) but they can model large-scale behavior of agents on system structure.

Using Systems Theory as a Foundation for Integrated Analysis

As argued in Chapter 2, variables where we can reasonably measure both continuity and change are those most typically forecast over long time horizons. These variables tend to be continuous with well understood stocks and flows. The beginning of Chapter 3 presented a framework for thinking about how to construct models that took into consideration widely accepted system behavior, both within and across boundaries.

This final section of Chapter 3 brings these threads together and presents an integrated approach to long-term modeling.

Integrated analysis is an approach to viewing the world that can be applied to empirical or theoretical considerations. It rests on the assumption that everything is connected to everything else. Integrated analysis is less interested in proving theories “wrong” and more interested in identifying under what conditions theories demonstrate utility and integrate these theories into tools (both empirical and theoretical) for analysis. The remainder of this chapter explores how integrated approaches can be used to produce quantitative models.

Integrated assessment models are a particular class of models that take into consideration key variables from a wide range of systems. This approach does not forecast trends in isolation, but endogenized the calculation of the widest range of variables and systems possible. The International Futures model—the cornerstone of this dissertation project—endogenizes the largest number of variables from across the widest range of system of any quantitative model in the world.

The section that follows highlights standard forecasting techniques (qualitative and quantitative, though focusing mostly on the quantitative). It underscores the importance of the explicit structuring of stocks and flows in a relationship to produce forecasts that can measure both continuity and change in dependent variables. This eventually builds to a broader discussion of the importance of integrated assessment modeling, the characteristics of IFs and then will point the way to how an integrated approach can also be useful in bringing together different strands of IR thought.

How We Forecast: a Stylized Introduction

Good forecasts of variables that measure both continuity and change require the following: a clear dependent variable, and a well defined time horizon, a combination of qualitative and quantitative approaches and the ability to factor in variables from a wide range of key systems, a characteristic of integrated approaches to modeling. For this example, I demonstrate this approach to forecasting using the population of Japan as an example. I contrast it with other formal modeling approaches.

Qualitative approaches—relying on mental models—are the backbone of the construction of quantitative models. Mental models form the basis of our assumptions about the world. A mental model about the change in Japan's population may go something like this: population is driven by fertility, mortality and migration. Japan's migration is very low, its fertility is low, and its mortality is low. One additional driver of future population size is the shape of the distribution in the population. Japan has a lot of old people, few young people and few people are having children. This will lead to a decrease in Japan's overall population sometime in the relatively near future.

A quantitative approach could start by simply extrapolating the historic trend. Extrapolation requires fitting a line to the curve by running a regression with time as the independent variable. In the example below the historic data is represented in the green line and it stops in 2005. The blue line is the extrapolation, with an r squared of 0.92, which is very high. It looks like we have a pretty good model and that the population of Japan will be somewhere around 130 million by 2030.

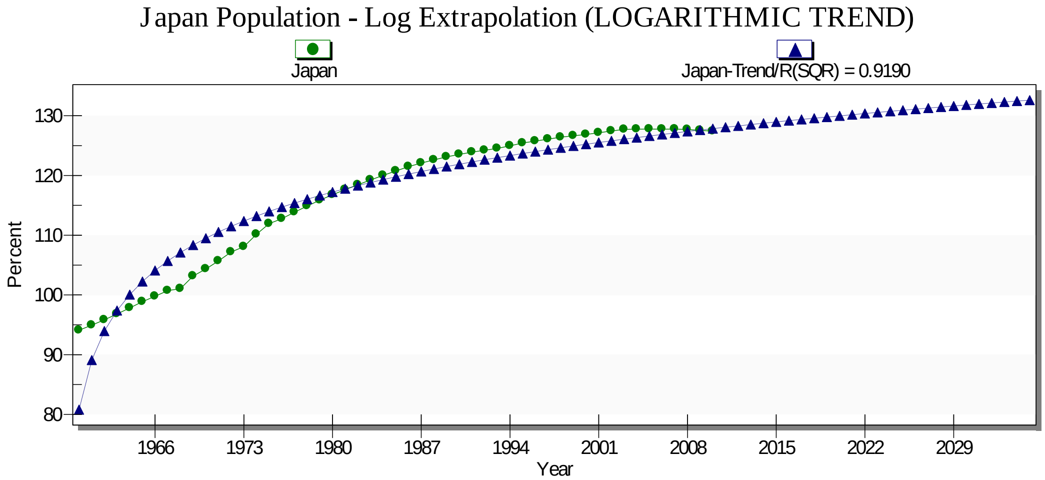

Figure 13: Japan Population - Log Extrapolation

We should not be overly convinced by the results from this method. It is entirely a-theoretical. To improve on this forecast we need to combine both theory and quantitative methods. To reinforce a point made earlier: this method doesn't embrace the structural character of population systems and thus can only forecast continuity in a trend and not change. I am interested in variables where we can forecast both continuity and change over long time horizons.

First we formalize the assumptions in our mental models. In quantifying this population model, I need to understand the mathematical relationships between all key variables. For example, what is the current fertility rate of Japan, and how do we expect it to change? What changes fertility rates? What is the current mortality rate? What changes mortality? What is the current population structure, and how does this affect future fertility? Once all of these assumptions are established within our quantitative model, it becomes possible to create forecasts.

In order to make this model quantitative, we explore the relevant trends statistically. This provides us with relationships between our key variables across time, and relative to all countries where there is data. After we have made our model—in this case, a demographic model of Japan—we now want to explore the implications from variables in other relevant systems. Demographic changes are driven by changes in education levels, income and the current structure of the population. For a good, long-term forecast, we want to take all of these potentially impacting systems into account. Let's compare our earlier extrapolation of the history of Japan's population with our dynamic forecast of their population. Below, the difference between our a-theoretical extrapolation and a dynamic model is a different in population in 2030 of around 15 million people.

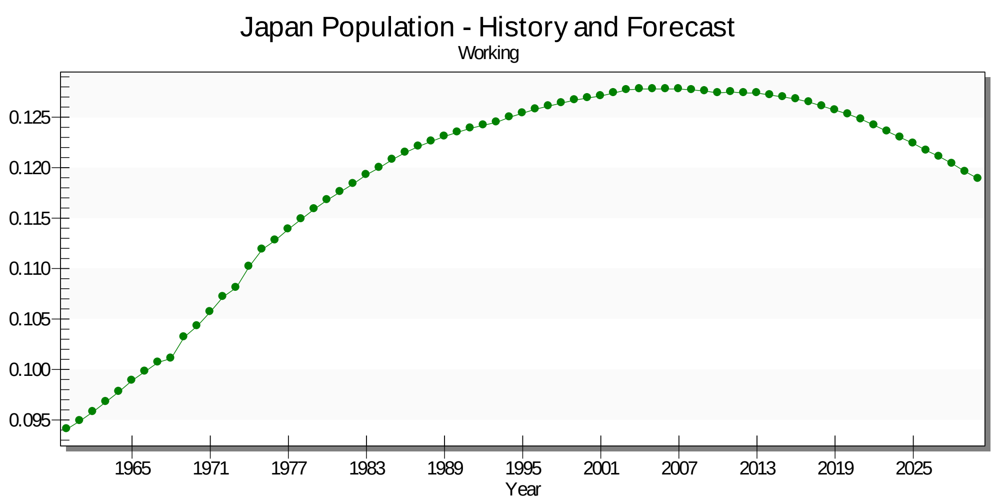

Figure 14: Japan Population History and Forecast

After we have our quantitative forecast, it is important to return to a qualitative assessment. Quantitative forecasts cannot stand on their own free from theory and subjectivity. Quantitative forecasts are born of qualitative assessment and their results are then analyzed using qualitative techniques. For our forecast of the population of Japan, we may wonder if our quantitative model is producing the results that we would expect. Are we showing the population decline that we expect?

One additional qualitative assessment tool to shape forecasts is the creation of different stories called scenarios. Scenarios area tools that forecasters should use to frame the uncertainty of any quantitative analysis. The base case is what you would consider to be the most likely unfolding of the trend that you are modeling. However, if you just present a base case, the results of your model will have done nothing to frame the range of uncertainty inherent in any forecast. For example, going back to our forecast of the population of Japan, how certain are we that mortality trends continue? What if there is an increase in migration?

Each of these questions can be explored by changing some variable within our quantitative model. If old people suddenly begin to live longer, we can extend our population structure and have the oldest die off at a slower rate. If migration increases, we can add to that variable on an annual basis, increasing the size of the population. Quantitative and qualitative models must be used in conjunction to make good forecasts. Qualitative methods provide creativity and flexibility to the analysis; they allow forecasters to imagine a wide range of possibilities that likely fall outside of the structure of quantitative models. Quantitative methods' strength lies in their transparency of assumptions and their ability to account of a large number of variables simultaneously.

How We Forecast: a Technical Introduction of Method and International Futures

Forecasts can be made using a range of technical methods. Meadows and Robinson (2002, 26–86) argue that there are four main types of models: systems dynamics, econometrics, input-output and optimization. I add to this a fifth type: agent based models. Meadows and Robinson argue that most applied models are actually “composite” in that they glean from a variety of approaches and methods. Integrated approaches tend to also be of this final, hybrid type.

Systems dynamics models were described above. They emphasize identifying system boundaries, stocks and flows and formalizing the relationships between these parameters and variables (Jay W Forrester 1987; Jay Wright Forrester 1971; Richardson and Pugh,III 1981; Sterman 2001). Then second approach identified by Meadows and Robinson (2002) is econometrics, which takes statistical relationships and represents them in formal mathematical equations to represent a system or systems in interaction. This method is most widely used—as its name would indicate—within the field of economics, and examples (Kennedy 1998; Maddala 2001). The third approach outlined by Meadows and Robinson is input-output models the first of which was famously constructed by François Quesnay in the mid 18th century (2005). These methods account for interactions between sectors of an economy (Batey and Rose 1990; Leontief 1986). These accounting approaches eventually were constructed more broadly represent society and account for stocks and flows among key actors in an economy (households, firms and businesses, for example) and are referred to as social accounting matrices (SAMs) (Graham 1988; Pyatt and Round 1979). The fourth approach involves optimization, which maximizes (or minimizes) a value when a choice between competing alternatives is presented. For example, when comparing the impact from climate change with the economic cost of mitigation, the ideal global carbon price can be established (Nordhaus and Boyer 2000; Nordhaus 2008). The final approach—not identified by Meadows and Robinson (2002) and tied to complexity theory—is agent based modeling (Bonabeau 2002; Johnson 2002; Gilbert 2002).

These different methods are often combined. One example of this is Computable General Equilibrium Models (CGEs), which (often) combine econometric, input output tables and optimization methods (Dixon and Parmenter 1996; Partridge and Rickman 1998; Partridge and Rickman 2010; Partridge and Rickman 2010). CGEs calculate economic growth endogenously (using econometrics, normally, though they can use system dynamics instead) and equilibrate prices between consumers and producers (optimization) and keep track of all of the intersectoral flows (input-output tables). This class of models is used widely.

IFs is another combined-type model. It draws on econometrics heavily to establish relationships between driving variables. It is conceptualized using systems dynamics approaches emphasizing stocks, flows and feed-back loops. It embeds economic production in an input output table, and then this in a SAM. It does not explicitly use optimization routines (as these are seen as being unrealistic for real-world application) but does approximate optimization in some cases when determining price.
International Futures (IFs) system is the world's largest global integrated assessment model. It has been under development for over 35 years, primarily by Barry B Hughes. It is a tool uniquely positioned to produce analysis that is integrated, systemic and cross-disciplinary. It has not been widely used for integrated analysis from the perspective of IR theory.

The IFs model endogenizes variables from the following systems, represented in Figure 16 below: population, economic, education, health, agriculture, energy, infrastructure, domestic governance, international politics, the environment and technology. It treats each of these systems for 183 countries interacting globally from

2010 to 2100 (with trade flows, FDI, aid and migration). IFs is housed at the Frederick S Pardee Center for International Futures at the Josef Korbel School of International Studies at the University of Denver in the United States (Hughes, Dickson, and Irfan 2010; Hughes 1999; Hughes et al. 2009; Hughes et al. 2009; Hughes, Dickson, et al. 2011; Hughes and Hillebrand 2006).

The IFs tool has been used for analysis conducted for the National Intelligence Council (United States National Intelligence Council 2008), the United Nations Development Programme (Hughes, Irfan, et al. 2011), the United Nations Environment Programme (United Nations Environment Programme 2007), the European Commission (Moyer and Hughes 2012) and various other governmental and non-governmental organizations. It is the primary tool of the African Futures Project, a collaboration between the Pardee Center and the Institute for Security Studies, a Pan-African think-tank (Cilliers, Hughes, and Moyer 2011; Eshbaugh et al. 2012; Gehring et al. 2011; Eshbaugh et al. 2011). It has also been used as a graduate level and under-graduate level pedagogical tool at various universities.

IFs is designed to allow analysts to accomplish three things: 1) explore relationships and longitudinal trends historically in order to 2) get a sense of where these trends and relationships seem to be unfolding (base-case analysis) so that 3) we can ask "what-if" questions that introduce wild-cards or allow us to ask questions about what kinds of global change needs to happen to achieve specific human targets. Philosophically, IFs is structured to consider three different spheres of interacting systems: Natural, Social and Individual. These are represented in the Figure below. In the inner-most circle, there is individual choice. This choice is both constrained and enabled by society. The middle-circle—that representing society—is constrained and enabled by the outer-most circle, representing natural systems.

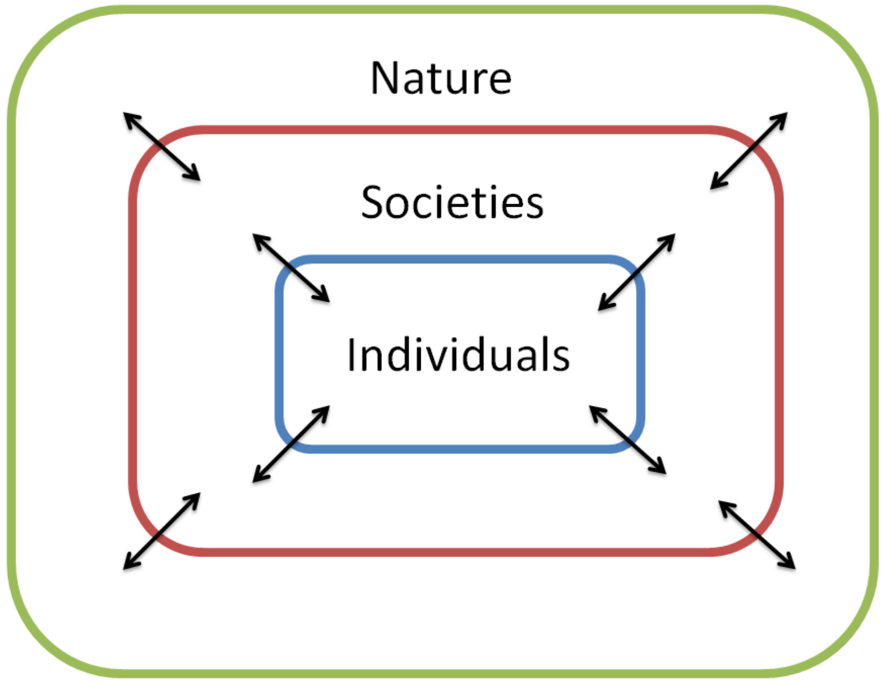

Figure 15: Conceptual Structure of IFs

The Figure 16 shows key links between all of the major sub-models represented in IFs. While the sub-modules below do not exactly map to the conceptual systems in Figure 15, there are overlaps. Agriculture, Energy and the Environment largely represent Natural systems. These provide the general foundation for modeling. In other words, without understanding the broader constraints and opportunities associated with changing stocks of fossil fuels and changing demand for global agricultural output, long-term forecasts are limited.

Next, domestic governance systems represent social systems. Domestic governance can be conceptualized as an emergent property of individual action that provides security and overcomes collective action problems. Governments have the ability to direct funds at other social systems, such as education, health and infrastructure.

These broader social goods then begin to move conceptually towards more individual systems, such as actual human life (population) and specific individual levels of development. Individuals are the units of the social system, just as societies and individuals are units of natural systems all standing in complex interaction.

Certain components in IFs have cross-cutting system impacts, such as technology. Technology writ large—the ability to apply knowledge to work more efficiently—is a complex variable that spans natural, social and individual systems. Natural systems constrain what is physically possible with improvements and change in technologies. Societies produce norms and policies that both enable and constrain the application of technologies. Individuals are the eventual source of new technologies as well as the direct application of technologies to specific ends.

There are key connections within and across each of these systems for the software. For example, energy systems are necessary for economic systems to function, and market-based mechanisms regulate the degree to which energy systems enable or constrain individual and social choice. Environmental systems operate in similar ways, though with different incentive structures. These systems provide the underlying set of elements that allow for human life to continue, but are not as frequently regulated by market mechanisms (for example as caused by the "tragedy of the commons") and are more frequently controlled by social systems (governments).

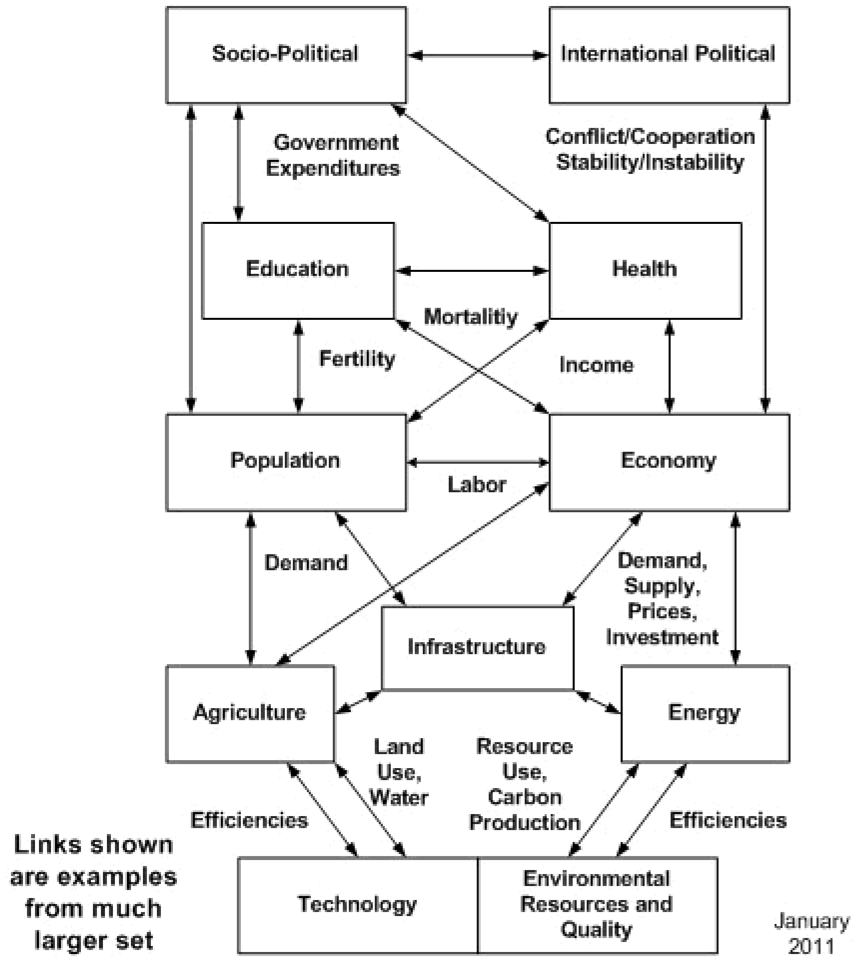

Figure 16: Block Diagram of IFs with Key Linkages

Social systems—almost entirely referencing governments in the IFs model—play a vital role in allocating resources and consuming goods that are aimed to promote security and improve human development that generally fall outside of the purview of market interactions. Within IFs, governments earn revenues through taxation and spend it in two ways: either directly transferring money to citizens in the forms of welfare or pensions, or by consuming goods and services. In IFs, governments can consume from the following categories: education, health, military, R&D, infrastructure or administrative costs. Domestic governance (and the linkages between natural and individual systems) is documented in the fifth Patterns of Potential Human Progress (PPHP) series focusing on governance (Hughes, Joshi, et al.).

Behavior of those operating within social systems—what I'm referring to as "individual behavior"—forms the conceptual core of the IFs model. Structurally, the model is not agent-based, but philosophically, the individual choice and development tends to be the ultimate focus of the project. The core of the model is the nexus between the population system and the economic system. The population model is an agent-cohort component model that represents both sexes across time for 5 year cohorts. It endogenously calculates both birth and death rates and uses UN population division variables for an exogenous treatment of migration. The economic model is a quasi-computable general equilibrium model that "chases" equilibrium, but never actually achieves it at any point in time. It represents six capital sectors (manufactures, materials, energy, agriculture, services and ICT), female participation in labor and both skilled and unskilled labor. It endogenously calculates levels of productivity based on a multi-factor representation of human capital, social capital, physical capital and knowledge.

Three key human development systems stem from the Demographic-Economic nexus. They have been written about in the Pardee Center's Patterns of Potential Human Progress (PPHP) series: Education (Hughes, Dickson, and Irfan 2010), Health (Hughes, Dickson, et al. 2011) and Infrastructure (Hughes, Rothman, et al.). Each of these systems further endogenized the calculation of changes in economic productivity tied to current levels of stocks and constrained by government budgets. Such an expansive integrated treatment of productivity exists nowhere else in the world.

The final block in the “individual” section of the overall stylized representation of the IFs model is technology. Technological change is embedded throughout the IFs system in relationships such as continued improvements in energy efficiency, or reductions in food loss. It is also measured physically, as a capital stock, a government investment category and in physical access measures (mobile phones, broadband, etc).

Conclusion

The dependent variable explored in this project is the character of interstate interaction as calibrated by the historic occurrence of conflict. This is measured through quantified Realist and Liberal accounts that can be forecasted (both with well understood stocks and flows). The only way to measure and forecast this dependent variable is through an integrated assessment model. IFs is the only model publically available that can be used to construct such a forecast.

Up to this point, this dissertation has cut into the seemingly intractable complexity of forecasting interstate relations by first identifying the kinds of dependent variables that we can forecast both continuity and change: those previously quantified with well understood stocks and flows. It then dove into the literature on war to talk about the specific pieces of literature that could be leveraged in a long-term forecast, arguing that we could forecast the “gas” on the rag, but certainly not the spark. The occurrence of conflict is the calibration tool for this project.

Understanding our dependent variable doe not a forecast make. Long-term forecasting requires a strong methodological foundation and this chapter explored the importance of both conceptual and applied systems thinking. This built to an introduction of the tool used for this analysis: the International Futures model.

We are now in a place to evaluate the role of International Relations theory vis-à-vis this project. IR provides tools for understanding the behavior of states in the international system and it has already been quantified in interesting ways. The next chapter first explores standard Realist and Liberal accounts of state behavior in the international system. It eventually argues for a third way of quantifying behavior that is sensitive to complex networks of interdependence and culture.

4. International Relations: Standard and Integrated Approaches to Understanding State Behavior

"Seek simplicity, but distrust it"
–Alfred North Whitehead

Introduction

Up to this point I have argued that state interaction matters, and that we should be interested in quantifying the character of this over long time horizons for the purpose of planning (Chapter 1). I then pieced together a broad foundation for doing this, first by identifying the kinds of dependent variables that we could talk about reasonably over long time horizons, and the specific dependent variable that I was going to use to calibrate my model. The forecast model used in this dissertation must have well understood stocks and flows, and should relate to broad structural pressures driving state behavior (Chapter 2). I also presented a conceptual and applied way of thinking about and producing these forecasts (Chapter 3).

I now turn to the theoretical substance of my quantified indices: the field of International Relations (IR). I explore standard Liberal and Realist accounts of state behavior and identify how they have been historically operationalized. The two substantive theories of IR[17] have been quantified at the macro level in the following ways: Liberalism is measured as country-level or dyadic interaction in democracy, trade or international organizations. Realism is measured as country-level percentage of relative material power or dyad-level relative parity in politically relevant pairs. Both approaches to measuring state behavior have been criticized. Much more on this in Chapter 5.

My goal is to take these bodies of work and operationalize them in a way that can be forecast within the International Futures (IFs) model. This is my orienting activity—my project's North Star—and it drives all decisions that I make. To that end, I am interested in basing my evaluation of Liberalism and Realism on the ways that they have been historically operationalized. I use the quantification done by others as the basis of my assessment of the *essential characteristics* of each theoretical perspective.[18]

I talk below about Liberalism and Realism throughout this project in general terms based on how they have been operationalized by others. This is incredibly problematic. Neither substantive theory is one thing; instead, they are rich tapestries that form an analytical backbone for asking questions about state behavior in the international system. Some of the criticisms that I levy against Realism and Liberalism actually originate internally to their respective research bodies. I highlight three criticisms of standard quantifications of both Liberalism and Realism: excessive parsimonious,

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[17] I use the phrase "substantive theories" here and "standard bearers" elsewhere because Realism and Liberalism have clearly stated objectives, well defined methods and a well structured and fairly uniform set of conclusions and prescriptions for state behavior.

[18] I am keenly aware of the problematic nature of talking about the "essence" of any theoretical position of perspective. See Wolff and Resnick for a useful critique of my approach (1987).

underwhelming treatment of complex networks, and a lack of focus on intersubjective norms and cultures.

While Realism and Liberalism have been criticized, no third theoretical approach to IR has emerged with a coherent research agenda that has been quantified at the macro-level across time. The closest “third way” comes from theories that deploy a constructivist framework. These approaches highlight the importance of socialization, ideas and cultures as key drivers of behavior that are largely missed by rationalist accounts of international relations.

Constructivist approaches do not have the same clear research agenda as Realism or Liberalism. Constructivist methods may agree on ontological frameworks—the “stuff” of the world out there—but they do not deploy a unified methods or assumptions. In fact, many who use the constructivist method would argue that the failings of Realism and Liberalism can be traced to an overreliance on inflexible independent variables. Those using the constructivist approach may wish to avoid this rigidity.

One component that unites criticisms of Realism and Liberalism is that they are overly parsimonious and do not actually map to things “out there”. Boiled down, Realism is interested in the effects of material resources and Liberalism interdependence. While parsimony can be a virtue, it can also lead to problems. If a theory claims that a single independent variable drives state behavior, and state behavior does not conform to expectations, then the theory must be taken into question and the assumptions expanded on.

A second critical thread related to Realism and Liberalism stems from their lack of focus on complex networks. Both substantive theories do take into consideration issues of connected relations between states. Liberalism does this by focusing on networks of international organizations, trade and democratic community; Realism considers networks in its treatments of alliances and state decisions to band-wagon or balance. Neither approach, however, operationalizes these networks in complex ways leading some authors to posit that they are empirically wrong.[19] While this criticism is primarily levied at Kantian Liberalism, it also applies to Realism.

A third critical thread is oriented towards the rationalist position of both Realism and Liberalism and takes issue with their lack of treatment of inter-subjective meaning making. Both substantive positions treat behavior as rational and oriented towards the maximization of an objective "good". This is problematic for many (mostly constructivists) who argue that language, culture and norms are not static things that can be responded to universally across time, but instead are fluid, changeable and contingent on the iterative interaction between structures and agents.

While critical perspectives vis-à-vis the standard bearers of IR do have similarities their differences should not be masked. They differ on their emphasis on structure verses agents, material verses ideational, path-dependent verses pliable, knowable verses unknowable, reductionist verses holist, just to name a few. The differences of these alternative positions are great, and should never be attempted to be brought together in one unified position.

To that end, I am interested in the standard-bearer, quantified accounts of IR, and document them below. However, I am also interested in what they miss, and if there is a

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[19] Some strands of Liberalism have been operationalized using dyadic trade as a driver, which brings about some nuance, but does not provide an understanding of complex networks. This is odd, as many strands of neo-liberalism focus on complex interdependence which derives from networks of connections between states.

way to improve upon what has already been achieved. There may be a third, account that can be shaken out of the cacophony of literature on international relations that uses extant data to tell a slightly different story about relationships between states in the international systems.

I use criticism rooted in conceptualizations of Liberalism and Realism drawn from standard operationalization to produce an additional measure that I refer to as the Cultures of Interaction Index (CoI Index). The CoI Index is *not* a third way of doing IR theory. In many ways, the CoI Index augments standard Liberal accounts of state interaction and refines methods of operationalization that relate to interdependence. While I do not make the claim that the CoI Index is an entirely new approach to doing IR, I do argue that it is a reasonable attempt to "get at" the operationalization of a measure that is responsive to concerns of those who talk about inter-subjective meaning making, norms and culture. Dyadic interaction can be non-Liberal but still retain high levels of the CoI Index, though there is clearly correlation between the two measures (at an r^2 of 0.33, see later in this chapter). Historic examples of countries with high CoI Index scores but low Liberal scores are found throughout the Middle East and North Africa, and were prevalent in the Soviet Bloc. There has also been a historic convergence between the CoI Index and operationalized Liberalism. The block diagram below highlights the eventual output that this chapter builds towards. It is a simple model where the three operationalized indices that I build each contribute to changes in the character of interstate relations. In Chapter 5 I statistically evaluate whether the three IR indices can be built together to form a better understanding of the behavior of states historically (using the calibrating dependent variable of the occurrence of international conflict). I find that they do, in fact, explain more together than in isolation.

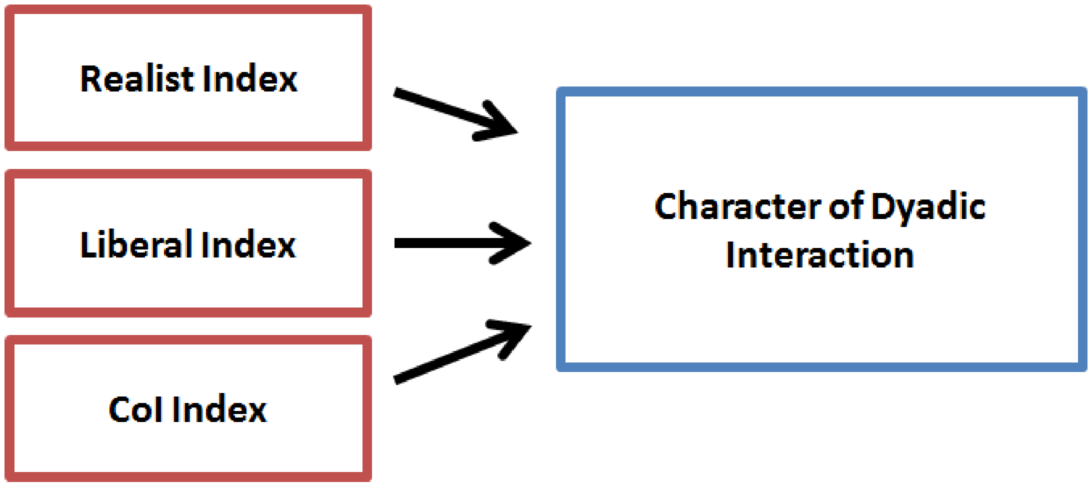

Figure 17: Overview of Quantified IR Theory and the Character of Interstate Interaction

IR Standard Bearer 1: Realism

"...the world remains what it always has been: international politics continues to occur in an anarchic, competitive, self-help realm. This reality must be confronted, because it cannot be transcended"
-*Christopher Layne*[20]

"We must remember that power is relative, not absolute"
-*Magnus Organski*[21]

"It becomes clear that the qualities we think of as conferring power—wealth, resources, manpower, arms—may indeed bring power, but not unless they are used to influence the behavior of others. They are the instruments of power, and an instrument that is not used is worth nothing"
-Magnus Organski[22]

Realists identify the causes of state action from the structure of the International Political System. While Realism is not a monolith, it is possible to draw on

[20] (Layne 1994, 49)

[21] (Organski 1958, 305)

[22] (Organski 1958, 98)

commonalities, which is my intention here. I am focused on the ways that it has been historically quantified, though I feel it useful to explore the theory conceptually as well.

The arguments of Realism can be neatly mapped using the logic of Hobbes in Leviathan (1914). All humans represent a threat to one another; even the weakest, armed with a sword, could vitally wound the strongest in her sleep. Thus, an overarching authority is needed to make sure that society does not descend into chaos. For domestic systems (hierarchical), the state government fills that void and ensures that wanton murder does not go unpunished. In the international system (anarchic), there is no equivalent authority: this ordering principle shapes the character of the units and creates a situation where—to draw from Thucydides—the strong will do what they can and the weak will suffer what they must (1954).

The ordering principle of anarchy does not provide any insight as to why there is variation in war and peace in the global system (Levy 1998, 142). If anarchy is a transhistorical fact and the deeper driver of conflict, then, *sans* intervening variables, war is a transhistorical fact. Thus, to understand the implications of Realism on understanding international conflict, we must further explore the variables that help to explain the historical variation in conflict and peace.

As even the weakest state can harm the vital interests of the strongest, and there exists no overarching authority to stop them from doing so, state decisions take the form of emphasizing material power (distribution of capabilities) to promote survival. As the only thing that people listen to in Hobbesian anarchy is force, the relative amount of capabilities between countries—the guns, soldiers and people a state has at its control—drive the type of relationships that states will have with one another.

Absolute power gains do not increase the relative security of one nation; if both nations gain equally, then neither nation has improved their ability to defend themselves from the other. Relative power gains, on the other hand, produce more security for the country that is increasing power, as this now places them in a position to more effectively fight off rival, now less powerful countries.

The concept of power that underlies Realist assumptions about the behavior of states in the global system is based mainly on material capabilities. This definition is well outlined by Dahl in what he refers to as an "intuitive" definition of power: "A has power over B to the extent that he can get B to do something that B would not otherwise do" (1957, 202–3). Others echo the sentiments of this definition:

> "Power can be thought of as the ability of an actor to get others to do something they otherwise would not do...Power can also be conceived in terms of control over outcomes" (Keohane 1977, 11).

Proximity is important because it indicates the capacity of one state to act on another. Since proximity is a straightforward measure[23], power becomes the contentious variable. Drawing on the work of others, Tellis et. al. argue that the measurement of power requires understanding that the concept is comprised of three separate parts: "...power as 'resources,' as 'strategies,' and as 'outcomes'" (2000, 14). Others have re-branded this approach, referring to it as the power of being, this power filtered through processes and the power of outcomes (Treverton and Jones 2005, ix, 1).

These three power perspectives build upon one another in their degree of complexity. For example, the "power of being" is crude material power: the amount of

[23] Though do not neglect even the complexity of measuring country proximity. This can be measured as the length of border shared, the distance from capitals, the distance from a certain percentage of the population, the distance between countries made contingent on missile capabilities, etc.

resources available. This material power must be filtered through a process that makes it useful. For example, how do we take resources—guns and people—and impart on them the skills to be good soldiers? The final level of power is the ability to control outcomes. Due to the complexity of the global system, this outcome-based power is the most elusive in this triad to causally pin-down. It is also the type that all states actively seek.

This conceptualization of material power neglects alternative measures of power. Josef Nye argues for smart-power which co-opts states, "…rather than coercing them" (1990). Barnett and Duvall's conceptualization goes well beyond material power measures, and further complicates conceptualizations of soft and smart-power.

> "In general terms, power is the production, in and through social relations, of effects that shape the capacities of actors to determine their own circumstances and fate" (Barnett and Duvall 2005, 8).

They argue that power is broken down into four types, and that these types can be classified based on two variables: whether the power works through social relations or direct agent interaction, and whether the power is constitutive or coercive. Thus, power where one actor impacts another actor—compulsory power in their framework—is much more closely aligned with realist conceptions of material power.

Realists refer mostly to hard, material power. Operationalized measures of power are treated in Chapter 5, but an introduction may be in order. Measures of power have been used in a wide range of academic studies, most notably the Composite Index of National Capabilities (CINC), which operationalized power based on total population, urban population, income, steel production, energy production, military personnel and military expenditure. Kadera and Sorokin argue that the CINC has played a fundamental role in the following IR accounts: expected utility models of war, polarity theories, hegemonic stability theory, long cycle theories and relative power cycle theory (2004). It has also been, "…used as a control variable for empirical investigations of many other substantive issues…" (Kadera and Sorokin 2004, 212).

Many observable phenomena fall out of Hobbes' account of the "state of nature", described above. There is the security dilemma, the seemingly intractable position where two states are mired in competition to gain more relative material power, thus precipitating even more relative power amassing. The choice states have between balancing and band-wagoning: when should they balance against the leading hegemonic power and when should they join forces with an alternative alliance? Next, there is the issue of hegemonic power transition, which argues that the "changing of guards" between one dominant power and a rising power produces a context in which international conflict is very likely. It is not the goal of this project to outline all of the colorful conclusions drawn by the full range of Realist scholars. Instead, this section treats some of the main Realist themes, debates and variants.

The security dilemma is a fundamental assumption that falls out of Realist theory.

> "The lack of international sovereign not only permits wars to occur, but also makes it difficult for states that are satisfied with the status quo to arrive at goals that they recognize as being in their common interest" (Jervis 1978, 167).

As states are keen on their own survival, and the promotion of material power is the only way to fruitfully accomplish this in international anarchy. As these structural conditions are constant, certain kinds of behavior are likely to emerge. One of these behaviors is a potentially intractable position that rival states can find themselves. Some argue that this is *the* foundational problem in international relations (Booth 2008, 1). The block diagram below outlines the causal mechanisms of this phenomenon. This problem can be exacerbated or mitigated depending on whether states pursue offensive or defensive strategies.

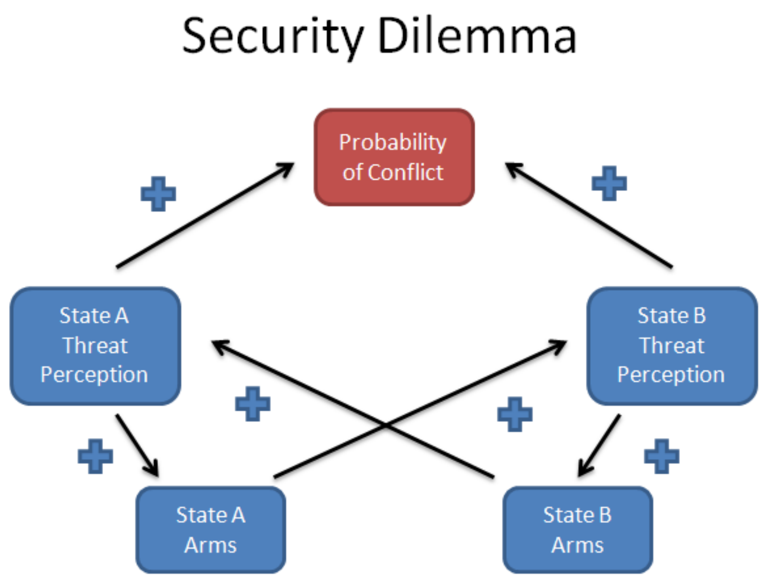

Figure 18: Security Dilemma as a Systems Diagram

Both states in this model are concerned with arms buildup in the other state; the perception of increased arms in one state is considered a threat by the other. As the perception of threat increases, states are encouraged to further build up their own arms to promote security. This, again, is perceived as a threat by the other state in the pair dyad. This leads to further buildup, and the perpetuation of a vicious cycle.

Another phenomena that falls out of Realist conceptualizations is balancing. Balancing happens when a country proactively counters the rise in capabilities in another country with a rise in capabilities of their own to mitigate perceived threat. *The* balance of power—as Vattel puts it through Bull— is a situation where no one state has preponderance over the rest (Bull 1977, 97). For Waltz, this behavior is a trans-historic fact (1979). Organisky sums up the main thrust of the balance of power by arguing that, when there is a multitude of actors with a range of material power capabilities, each of whom is attempting to improve their own relative power position, "…there is a tendency for the entire system to be in balance" (1958, 273). When such a situation exists, it is claimed that peace will prevail, and that particularly smaller, vulnerable nations will retain their independence.

The reason that states balance is to produce stability within an otherwise chaotic international system. Singer and Deutsch define system level stability as,

> "the probability that the system retains all of its essential characteristics; that no single nation becomes dominant; that most of its members continue to survive; and that large-scale war does not occur" (1964, 390–1).

According to Little, its first usage was in reference to Italian city-states (2007, 4). Writers have identified six different ways that nations may act in order to maintain the balance: through armaments, seizing territory, buffer zones, alliances, intervention and the practice of divide and conquer (Organski 1958, 275–7).

This approach to understanding state behavior in the international system has come under much criticism. First, there is a fundamental misunderstanding about what actually constitutes balancing. Haas has identified 8 distinct usages of the term (1953). Little compares two standard accounts of balancing: Waltz (1979) and Mearshimer (2001) using a treadmill as a metaphor: in Waltz's account, the treadmill can slow down—the intensity of structural drivers will decrease causing a stable international system—when there are only two states running together (a bipolar system), for Mearshimer, the treadmill will only slow down when there is one person running (global hegemony), for the classical realists, such as Morgenthau, the treadmill only stops when there is a multitude of people running. The later argument of Mearshimer is much less an account of “balancing” and much more an attempt to highlight the potential stability produced by hegemony, assessed in the next sentence.

The pre-1945 Europe was quite violent because there were no nuclear weapons and there was a multipolar world. The post 45 world was more peaceful because of bipolarity.

> “A bipolar system is more peaceful for three main reasons. First, the number of conflict dyads is fewer, leaving fewer possibilities for war. Second, deterrence is easier, because imbalances of power are fewer and more easily averted. Third, the prospects for deterrence are greater because miscalculations of relative power and of opponents’ resolve are fewer and less likely” (Mearsheimer 1990, 14).

Empirically, this account of states balancing in anarchy was explored by a group of authors (Kaufman, Little, and Wohlforth 2007). These authors found that balancing occurred in around 50% of the case studied. In the other 50%, there was no balancing. This kind of empirical inconsistency has led some to argue that there are different kinds of balancing, and that states sometimes neglect to properly balance. Walt analyzes the balance of threat (1985). He argues that balancing doesn’t happen all of the time, as previous realist scholars argued, but only happens when one state perceives another state to be a threat, which would not occur in all circumstances. For example, if the EU gains in material capabilities relative to the US, there will be no counterbalancing, but there would be if, for example, Iran acquired a nuclear weapon. Schweller explores under-balancing, which is the inability or unwillingness of certain states to balance against perceived threats (2006). This lack of traditionally defined balancing stems primarily from domestic political circumstances. Little furthers this and argues that "reverse balancing" sometimes occurs, which represents,

> "...collaborative policies that are designed to promote stability by reducing the level of arms or implementing measures that are designed to inhibit the use of weapons" (2007, 172).

Others argues that the concept is inadequately nuances, as more fruitful analysis would look at both polarity as well as concentration, which is, "…a function of: (1) the number of major powers in the global system; and (2) the relative inequality of capabilities among the major powers" (Mansfield 1993, 111).

The balance of power approach to exploring behavior in the international system has been widely criticized (E. B. Haas 1953; Randall L. Schweller 2006; Organski 1958; Little 2007). Hegemonic stability, power-transition, long-cycles and Kondratieff waves have been put forward as alternatives to this approach. These models are diverse, but all focus on change in centralized power in the international system and the behavior of others in response to this consolidated material control. Some have argued that this genre of theory does not belong in the Realist camp (Thompson 1988, 44) though others disagree and claim that it shares the same assumptions as realists, but places a different emphasis on the possibility for order in international anarchy (Levy 1998, 148). Because of a focus on material power in anarchy, I argue that hegemonic stability, long-cycle theory and power transition theory all fit well within a general understanding of realist approaches to IR theory.

Levy argues that the key distinction between Realism isn't between classical and neo, but between theorists who explore balance of power or hegemonic stability (Levy 1998, 146).

> "Hegemonic theory is a structural theory that incorporates power transition theory and hegemonic stability theory and that downplays the importance of anarchy" (Levy 1998, 146–7).

One key demarcation between hegemonic stability and the balance of power is a focus on concentration and not polarity. Emphasizing the issue of concentration brings about different kinds of questions, and may be empirically more interesting than focuses on the issue of polairty (Mansfield 1993).

The origins of hegemonic stability theory are traced back to Kindleberger, though he did not explicitly use the term (1973). Writing about the organization of the international political economic system, he argued that a global hegemon was necessary to bring about stability, and that this could only happen with one state in control: "…for the world economy to be stabilized, there has to be a stabilizer, one stabilizer" (Kindleberger 1973, 305). While this leader did not represent global hierarchy, it was able to set the rules of the game and incentivize/coerce others to participate.

International hegemony is defined as, "the leadership of one state over other states in the system" (Gilpin 1981, 116). This hegemonic leadership must be taken explicitly, and is nothing without direct action. It requires that, "one state is powerful enough to maintain the essential rules governing interstate relations, and willing to do so" (Keohane 1977, 44). This state must have consolidated management over material resources, specifically, it must be able to control, "…raw materials…sources of capital…markets, and competitive advantages in the production of highly valued goods" (Keohane 1984, 32). The position of a hegemonic leader must be that of, "…an unrivaled position of economic and military superiority among the core states," who can, "…shape the operation of the international system" (Goldstein 1988, 5).

Proponents of hegemonic stability theory argue that periods of peace are relate to and contingent on there being a global leader.

> "Pax Britannica and Pax Americana, like the Pax Romana, ensured an international system of relative peace and security. Great Britain and the United States created and enforced the rules of a liberal international economic order" (Gilpin 1981, 31).

Others have argued that, while hegemonic situations do breed a certain kind of cooperation, they are not the only source of it. There can be cooperation in the international system in non-hegemonic situations (Keohane 1984, 32).

Periods of hegemonic peace are not the sole focus of this approach. Assumptions about the rise and fall of global hegemons are very germane to the understanding of the future of international conflict. This school of thought has been the only approach to IR theory that offers explicit and rigorous sets of forecasts about the future of international conflict (Thompson 1988, Chapter 12; Organski 1980, Chapter 17; Rasler 1994, Chapter 10; Goldstein 1988, Chapter 15).

Modelski took the initial cut in measuring the concentration of global power in the hands of hegemons over time by tracing the amount of total naval power that the great power nations possessed from the 1500's to the end of the 21st century (Modelski 1987; Modelski 1988) The graph of this power concentration, reproduced below, indicated that naval material power—a proxy for general material power and global reach—has ebbed and flowed through history.

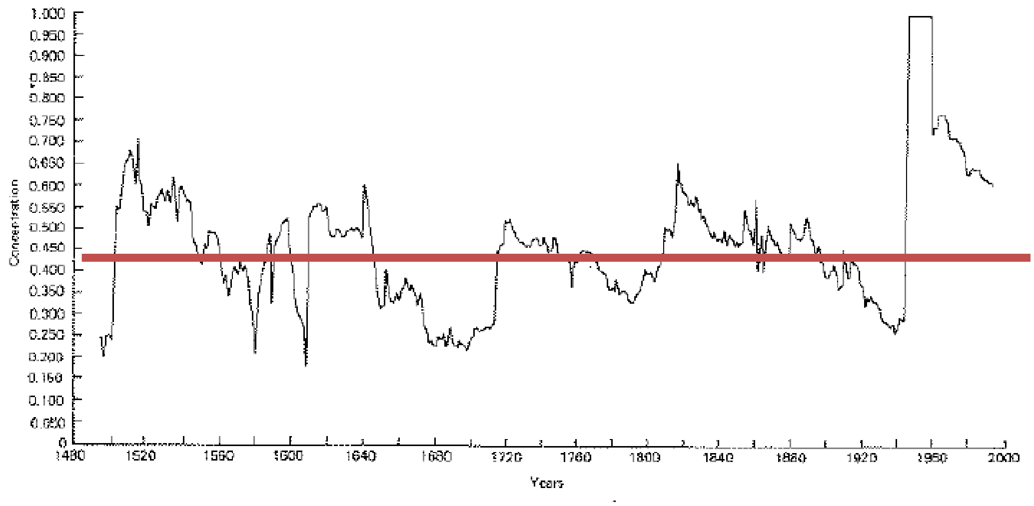

Figure 5.3 The long cycle, 1494–1993

Figure 19: Modelski and Global Naval Concentration (1988, 109), Author's Red Line

> "The long cycle of global politics refers to the process of fluctuations in the concentration of global reach capabilities which provide one foundation for world leadership" (Modelski 1988, 97).

This analysis of global hegemonic control, shown above, outline a series of patterns in material power consolidation. If we set the threshold for hegemony at 40% of total global naval power, indicated above by the red line, 6 periods of global rule are identified:

- the Portuguese until the last half of the 1500s
- the Spanish for about 25 years up to 1600
- the Dutch from the early 1600s to about 1650
- the UK from the early 1700s through to the end of WWI with a blip in the late 1700s up to the end of the Napoleonic wars
- the massive hegemonic control of the US after the end of WWII

It is argued that this oscillation between concentration and deconcentration does not happen by chance; there are underlying sets of forces that help to drive the ebb and flow of global power. First, there is the structure of the international system when a global hegemon exists. The pyramid outlines the relationship between different kinds of states in the international system coupled with their relative satisfaction or dissatisfaction with the status quo. The global hegemon is understandably entirely satisfied with the situation that it controls. As we move down the pyramid—from countries with more global power to those with less global power—dissatisfaction with the system becomes more apparent.

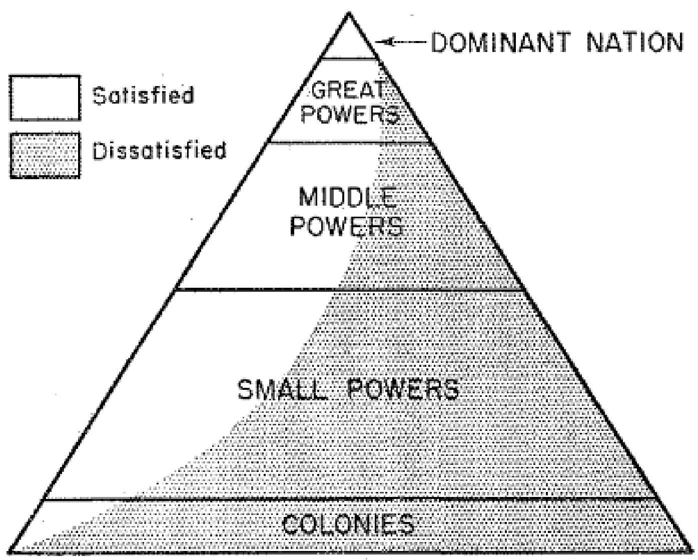

Figure 20: Organski's Hegemonic Control and System Satisfaction (1958, 331)

Though all nations subsumed within the power of the global hegemon represent some level of dissatisfaction with the current global system, this does not indicate that conflict will arise. For that to occur, power must be deconsolidated at the top, and a challenger nation must rise to try to take the reins of global leadership.

> “Power transition arguments emphasize the destabilizing and conflictual implications of a challenger catching up to a declining leader. As the transition is accomplished…war between a rising challenger and a declining leader is most probably” (Rasler 1994, 38).

The variation in concentration and deconcentration in material power must be accounted for in this argument. It is clearly argued that these oscillations are not random nor are they mechanical processes (Goldstein 1988, 6). Instead, the general consensus is that there are three stages in the power transition: first, there is the stage of “potential power”, where a nation is pre-industrial and lacks the means to exploit resources for the end of power and control. The second stage—the transitional growth in power stage—involves a move towards industrialization and the harnessing of previously latent power. Power maturity is the third stage, and is marked by a stagnation of the radical growth of the second stage (Organski 1980, 302–4). Organski argues that the third stage of power deconcentration is not the fault of the mature nation, but is rather being driven by other developing nations moving through the second stage of power transition. This further emphasized the importance of the role of relative power in the face of absolute power (Organski 1958, 305).

Goldstein identifies four potential causes of oscillation in global production which leads to down-turns in hegemonic control of material power: the capital investment theory (where long-term investments in, say, infrastructure begin to depreciate), the innovation theory (where growth happens around key technological innovations, such as the automobile), the capitalist crisis theory (where the long term rate of profit is reduced by factors such as imperial overextension) and the war theory (where wars create inflationary shocks causing long-term waves in overall production) (1988, 24). Levy chalks the fall of hegemons up to the following: "Differential rates of growth, the costs of imperial overextension, and the development of vested domestic interests lead to the rise and fall of hegemons" (Levy 1998, 148).

Rasler and Thompson make the power-transition-leads-to-war argument more specific. They argue that it is not just the concentration of one global power relative to all others, but the concentration of one global power relative to the next most powerful region. Further, they claim that,

> "…the most dangerous structural situation has been a deconcentrating global system and a reconcentrating central regional system. Such conjunctures have encouraged the outbreak of a series of global wars over the last five hundred years" (Rasler 1994, 59).

This argument it outlined in the graph below. The y axis represents the relative degree of power concentration in the hands of one global hegemon, or the most powerful region. As the line moves down, there is less concentration in the system and power is more widely shared. The grey vertical lines represent the occurrence of major, systemic war. The occurrence of these conflicts tend to coincide with levels of deconcentrated global material power. These conflicts also tend to produce high levels of concentration in material power in a new global hegemon (Rasler 1994).

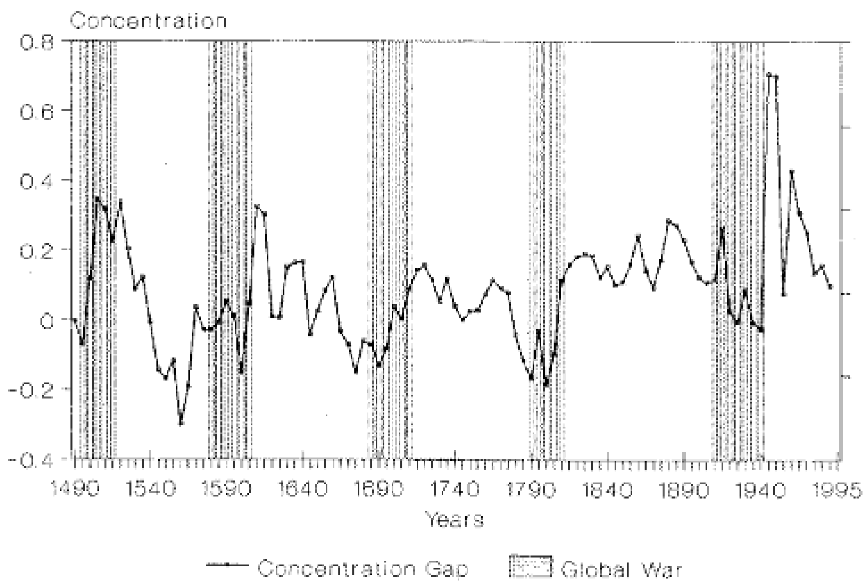

Figure 4.2 The Global-Regional Concentration Gap and Global War

Figure 21: Rasler and Thompson (1994, 68)

Hegemonic stability, power transition, long-cycle and Kondratieff waves all tell a certain kind of compelling story about nations pursuing power in anarchy, staples of realist thought. It is clear that some pattern does emerge within the long-reach of this theory, and the arguments for global stability—defined as the absence of systemic wars—in the presence of a strong global hegemon are compelling.

While the broad patterns identified by this approach appear compelling, there is much that is left out. First, the explanations for the causes of the long-cycle of power transitions are not entirely compelling. The list of explanations causing these fluxes is ad hoc, and lacks empirical validity. It seems more likely that these scholars have not identified the root of changes in the global system, but the fact that changes in the power composition of the global system do occur. Separate from etiology, this is in itself interesting. The implications of a de-concentrated global system on the likelihood of a systemic war are a powerful argument separate from the attempts to divine the cause of the fall of system leaders. This is the value of this approach to understanding the future of international conflict.

IR Standard Bearer 2: Liberalism

"We live in an era of interdependence. This vague phrase expresses a poorly understood but widespread feeling that the very nature of world politics is changing"

-Robert O Keohane[24]

As with Realism, Liberalism is a substantive research agenda within the field of IR. While not a monolith, boiled down to its essence (as historically operationalized at the macro level), it emphasizes three types of interdependence that can mitigate the corrosive impacts of an international system characterized by anarchy: through increased trade, democratization and membership in regimes of global governance. These three theoretical foundations can be traced back to Kant's Perpetual Peace (Kant 1991).

Interdependence is the key driving variable in Liberalism and stands in opposition to Realist claims that relative material gains are the key driver of behavior in the international system. If Realist claims of conflict are indeed the general trend in the international system then, "…institutionalized patterns of cooperation are particularly in need of explanation" (Keohane 1982, 325). These qualities of cooperation are represented by three kinds of interdependencies: institutional interdependence, material interdependence and normative interdependence.

Institutional interdependence arises from membership in international organizations and the signing or ratification of UN treaties. This is the most direct measure of embeddedness in regimes of global governance found in the Kantian triad,

[24] (Keohane 1977: 3)

and one that I specifically focus on. Kant referred to these kinds of treaties and organizations as being fundamental to perpetual peace. In his terms, treaties could lead to more binding and comprehensive forms of governance, such as a federation of states based on an international constitution. This was not, for Kant, the same as a world government (1991, 102). Instead, each state would retain its substantive sovereignty (domestic monopoly on the use of force) but their external sovereignty on the use of force would be curtailed. This federation would be more binding than a treaty, though treaties are likely to be necessary initially for the foundation of this kind of federation.
Thicker interdependencies between states are likely to arise from material and normative interdependencies. Material interference may stem from engagement in trade among states. When nations specialize in the production of specific goods and services for which they have a relative advantage in production, comparative advantage is produced. Thus, more states are taking more specialized products to the global market and are reliant on others to import materials previously produced domestically.

Kant referred obliquely to global trade as being one of the cornerstones of perpetual peace. He wrote that the world should embrace universal hospitality where all people are free to move from one state to another. This would seem to promote movement of labor, but not capital. However, while Kant may not have directly alluded to the impact of globalization on security (he was writing at a time when levels of global trade were small compared to the modern era) many have attributed this to his body of work (Oneal, Russett, and Berbaum 2003; Russett, Oneal, and Davis 1998; Russett 2001).

Democratic domestic governance regimes are the source of normative interdependence. The argument here is that states that value the same kind of governing regime have certain ideational affinities with one another that form a kind of relational interdependence. Some have referred to this not only as normative constraint, but also structural constraint. I discuss that below, but believe that the normative driver is more important for issues surrounding global governance.

Kant argued that republicanism was a crucial determinant of perpetual peace, as it was the only form of government that separated the executive from the legislative branch (1991, 101). Kant argued that, because decisions to go to war were made by the population as a whole (at least those with the political rights to vote), that they would be much less likely to engage in international conflict. Kant's claim is referred to in contemporary terms as institutional or structural constraint that makes democracies less likely to go to war (the war-proneness of democracies is debated below) (See the former for a description of institutional constraint and the later for a general critique Doyle 1983; Layne 1994). Other causal claims about the role of democracies and peace are referred to as being normative (Maoz and Russett 1993). The normative account claims that bilateral democracies will not go to war because they value the same kinds of things (pluralistic decision making, transparency, etc).

I am interested in the enabling effect of the normative driver brought about by dyadic democracies for implications for global governance. If two states are democratic, there are two implications for global governance: the first is that bi-lateral democracies may be more likely to trust one another as they have embraced similar domestic governing structures and thus embed themselves in the same kinds of regimes, institutions and norms. The second is that the institutions that are created and promoted by these organizations are likely to be more democratic and pluralistic.

Kantian Liberalism is most closely associated in academic literature with bilateral peace and not global governance. There is much literature on exploring this issue, and I use that as a foundation for forecasting this trend as an index. The literature indicates that giving equal weight to the impact of democracy, IO embeddedness and levels of trade is conceptually sound, and this is the strategy that I pursue later when I build my index of Kantian Liberalism.

By far the largest amount of conceptual and empirical effort exploring Kantian Liberalism's relationship with peace has gone into exploring the implications of the democratic peace. While there is not universal consensus (Spiro 1994; Layne 1994; Farber and Gowa 1997; Cohen 1994), the overriding empirical evidence points to two characteristics that define democratic interaction in the international system: 1) bilateral democracies are less likely (if likely at all) to use violence to solve problems (Bremer 1993; Mesquita, Siverson, and Woller 1992; Maoz and Abdolali 1989; Maoz and Russett 1993; Maoz and Russett 1993; Owen 1994; Russett 1993) but 2) they are also more likely to engage in violence with non-democratic states (Rousseau et al. 1996; Hegre et al. 2001; Eric Gartzke and Weisiger 2010)[25].

The implications of high levels of dyadic trade on the occurrence of conflict have also been explored, with a range of mixed results. Initial studies show clear pacific links between levels of trade and pacific interstate relations (Domke 1988; Mansfield 1994;

[25] See (Rousseau 2005) for an argument that democracies are more pacific with all regime types. Russett makes this point repeatedly (see 2003 page 373).

Oneal and Ray 1997; Reuveny and Heejoon Kang 1996; Reuveny and Heejoon Kang 1996). This rush of literature was met with some resistance, either due to concerns over methodology (Kim and Rousseau 2005; Beck, Katz, and Tucker 1998) or results (Barbieri 2002; Barbieri 1996; Barbieri and Schneider 1999). This series of critiques of the relationship between trade and conflict were responded to, and more recent approaches have further honed the relationship between bilateral material interdependence and the occurrence of conflict.

Oneal and Russett (1999) argue that the impact of trade as a mitigant of conflict can be seen by exploring only politically relevant dyads (those that are contiguous or that have a Great Power associated). Gartzke (2007) argues that the strong findings that democracies cause peace but the weakness of conceptual accounts of this may be because it is actually capitalist dyads that cause peace. Martin, Mayer and Thoenig (2008) have a different approach to explaining the relationship between trade and conflict and they argue that bilateral trade reduces conflict (because the opportunity costs are too high), but that high levels of multilateral trade increase the likelihood that two countries will engage in conflict (because other trading partners will take up the slack caused by the lack of trade between warring parties). In a broadly sweeping quantitative review of the drivers of international conflict, Bennett and Stam find that international trade does have a statistically significant and important pacifying impact on dyadic pressures for war (Bennett and Stam 2000).

The third piece of the Kantian puzzle is embeddedness within international political norms, regimes and institutions. This driver of Liberalism has received the least amount of attention, and evidence on its overall impact on international peace is mixed.

Bennett and Stam find no significant relationship between this variable and the occurrence of conflict in their sweeping study. Russett and Oneal argue that this is a byproduct of exploring the impact of membership in international organizations for all dyads in the international system, and not just for politically relevant dyads (2001). When politically relevant dyads are selected, membership in international organizations becomes a significant pacifying effect.

More recently, Pevehouse and Russett have argued that international organizations have a pacifying impact on bilateral relations when the members of those international organizations are democracies (2006). A network effect was explored in a piece arguing that traditional empirical measures of IO impacts on the security situation were misleading, as they only explored the relationship of two states in one institution, and not the broader impacts of multiple states' ability to effect indirect diplomatic and normative pressure on other states to conform (Dorussen and Ward 2008). Others argue that IOs are not simply one kind of thing, and show through empirical analysis that security IOs are better at promoting peace than economic IOs, IOs that are more thoroughly established are better at promoting peace, and, in line with the work of Pevehouse and Russett, that IOs where there is homogeneity among members also helps to promote peace (Boehmer, Gartzke, and Nordstrom 2004).

In a series of three articles, Bruce Russet and various colleagues explore the relative impact of the three legs of the Kantian tripod on international conflict. While methods change slightly, they find some consistency.

Table 2: The Liberal Tripod in IR: Percentage Reduction in Conflict Contribution from Various Components of Liberalism

Reduction in the Probability in Dyadic Conflict	**(Oneal, Russett, and Berbaum 2003)**	(Russett 2001)	(Russett, Oneal, and Davis 1998)
Impact of Dyadic Democracy on Conflict	86%	33%	35%
Impact of Trade on Conflict	32%	43%	38%
Impact of IO Membership on Conflict	43%	24%	23%

It is not the endeavor of this project to reconcile all of the competing perspective, methods, data sets and theories that pertain to the three pillars of Kantian Liberalism vis-à-vis international conflict. Instead, the above discussion was to promote the idea that each of these aspects of Kantain Liberalism are likely important to issues of international conflict. Whether a state is liberal seems to matter for peace. It is likely that, if it matters for the absence of conflict, it may matter for the presence of cooperation.

Cultures of Interaction: Pulling some threads from the cacophony of criticism

Above, I treated Realism and Liberalism in general terms that are relevant to how they have been historically quantified. As stylized accounts of behavior in the international system, they hold important insights. In Chapter 5 I test whether the quantification of these theories explains more in conjunction or isolation. I show statistically that they do, in fact, explain more as an aggregated index than as isolated indices.

This section brings together some of the criticisms of both Realism and Liberalism and attempts to highlight a third approach to thinking about quantifying IR. This approach which I call the Culture of Interaction Index is an attempt to “pull threads” from the wide range of critiques of both Realism and Liberalism with the help of a more constructivist orientation (Wendt 1999). To be relevant for my project this third approach must satisfy the following:

- be operationalizable on a large-scale from existing measures of state behavior with historic series for most dyad years[26]
- have reasonable historic longitudinal behavior across time
- contribute to improving and building upon Realist and Liberal accounts
- attempt to “get at” something that isn’t captured by either the Realist or Liberal measures, even if in a very limited and possibly contentious way

Realism and Liberalism (as they have been historically operationalized at the macro level) are criticized for various reasons. Here I make the argument and document with citations that critical approaches can be broken down into three strands that build sequentially. First, the theoretical foundations use univariate drivers (anarchy for Realists, interdependence for Liberals) that may be overly simple. Second, and stemming from the first, these substantive approaches do not treat complex networks with sufficient depth and complexity. Finally, and building on the previous two criticisms, these

[26] A dyad year is a measure that considers two countries for a single year, such as Belgium-Netherlands-1980.

substantive IR approaches do not treat intersubjective meaning making—such as culture—adequately or at all.

Parsimony can be a useful thing: the model of state behavior that can explain more using less can be considered "better".[27] The real world, however, tends to complicate this: it is exceedingly easy to use fewer independent variables; it can be exceedingly hard to know if you have "explained more". Explaining a few "…big and important things" (Waltz 1986, 329) is nice, but we must be concerned if our explanatory power is sufficiently comprehensive to warrant the limited assumptions made (Sørensen 2009). Snyder says that, "…it is enough that [a single theory] highlight 'a small number of big and important things'; and that is all that Kenneth Waltz…claims for his theory," (1996, 167) Donnelly persuasively counters:

> Only for peculiar purposes would it be helpful to represent all animals as either big or small. Conceptualizing color as either red or blue is not 'more parsimonious' than the standard red-orange-yellow-green-blue-violet-spectrum but a gross distortion. 'The world' and our analytical purposes set the limits of useful parsimony (2009, 78).

The following pages argue that both Realism and Liberalism have been historically operationalized in ways that are overly parsimonious. Both approaches miss important things about the international system and the behavior of states. Theories should be internally logically consistency and should also conform to real-events, out there. If theories miss important things out, in the world, then there are intervening variables that they have not considered.

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[27] This is referred to as "Occam's razor" which privileges hypotheses that make fewer assumptions but which makes no claim on the output of a model's performance across time.

Realism has been criticized because the world it theorizes does not seem to conform to the actual world, out there. As cited previously, Keohane gets at this particularly well: if the world is, as Realists claim, characterized by the security dilemma that emphasize the importance of relative power gains, any, "…institutionalized patterns of cooperation…" is really of interest (1982, 325). In the international system, patterns of cooperation occur.

The lack of empirical verification has led many Realists to argue for the addition of intermediate variables that augment the original and simple claims of Waltz. This has led some to conclude that Realism is an approach to doing IR that is on its way out (Vasquez 1997). Legro and Moravcsik make it clear:

> The central problem is instead that the theoretical core of the realist approach has been undermined by its own defenders—in particular so-called defensive and neoclassical realists—who seek to address anomalies by recasting Realism in forms that are theoretically less determinate, less coherent and less distinctive to Realism (1999, 6)

The authors continue by arguing that new versions of Realism try to take into consideration what earlier Realists had tried to argue against, like economic interdependence. It would be a boon to Realism if it could be shown that, from Machiavelli to Morgenthau the structural pushes and pulls were the same. For example, minimalist Realism retains only anarchy and rationality as assumptions, watering down the theoretical perspective beyond recognition.

Realist assumptions about the behavior of states in the international system—as originally stated by Waltz—seem to be excessively parsimonious and require constant fiddling: academics take them, add bits, remove bits and attempt to make them more palatable vis-à-vis the actual behavior of states in the international system. Liberalism—as originally posited by Kant and as operationalized by many, identified previously in this chapter—also makes limited assumptions about the world and draws large conclusions. If interdependence existed at the same time as conflict, Liberalism is as susceptible to criticism as Realism.

The Democratic Peace thesis—one of the legs of the Kantian tripod—has been argued by some to not be a historic constant and thus also suffer from empirical verification. Farber and Gowa claim that democratic peace may be more of an artifact of Cold War alliances:

> "…we find that there is no statistically significant relationship between democracy and war before 1914…Our analysis shows that it is only after 1945 that the probability of war or serious disputes is significantly lower between democratic states than between members of other pairs of states" (1995, 124).

There are various examples of conflict between countries that are arguably democratic. Ecuador and Peru have gone to war three times since the middle of the 20th century. Israel attacked democratic Lebanon in 1948, but had yet to vote. Many people code the German Republic in the run-up to WWI as a democracy or a quasi democracy. Finland allied themselves with the fascist powers in WWII from 1941-44 to avoid annexation by the USSR, thus pitting them (a democracy) against allied democracies (they were also bombed by the UK at one point). The US attacked the Philippines, then a developing democracy, though they did not have time to hold elections before their loss in 1899. Some code Spain as democratic in 1898, and this would put the Spanish-American war into question. Hitler was democratically elected, and legally suspended the constitution. Various measures of Militarized Interstate Disputes with fatalities occur between states that are very liberal, including Turkey and Cyprus in the 1990s. This is not to mention Militarized Interstate Disputes that occur between states without fatalities that are extremely liberal, like the Cod Wars of the 1950s and 70s between Iceland and the United Kingdom.

The method for statistically evaluating the claims of democratic peace theorists is also contentious. Some have argued that, because democracies represent such a small proportion of the membership of the international society for the vast majority of history, that their overall share of the sample size is so small as to artificially benefit proponents of the Democratic Peace (Mearsheimer 1990, 50). Thus, the reason that so few democracies have gone to war is a product of statistical method and coding (Spiro 1994, 51). Spiro finds that Doyle acknowledges that the war between Peru and Ecuador occurred when they were both liberal (1994), but that it, "...came within one to three years after the establishment of a liberal regime...before the pacifying effects of Liberalism could be deeply ingrained" (Doyle 1983, 213).

A second assumption of Liberalism is trade can lead to higher levels of interdependence that can help promote absolute gains and mitigate the corrosive impact of the security dilemma. Some argue that this is not always the case. During the period of rapid globalization, Liberalism has done much to promote stability. However, instead of being a driver of peace in the early 20th century, it was actually a driver of war (Rowe 2005). This leads Rowe to state strongly: "This conclusion that globalization pacifies international relations is not just premature, it is wrong" (2005, 408).

It is not simply that trade connection matters, but the degree to which dyads are connected. Barbieri argues that there is a curvilinear relationship between trade integration on a dyadic basis and the occurrence of war. If a country has little to no trade integration, there is an increased chance that they will go to war. If they have a very high interdependence—whether asymmetrical or symmetrical—this will also increase their chance of going to war. If dyadic pairings have a moderate level of trade integration, then this will decrease the chance of going to war (1996). Therefore, simply increasing trade integration does not reduce the chance of conflict.

In a separate piece, Barbieri and Schneider find a range of contradicting evidence on the relationship between trade and peace concluding the following:

> What are the origins of the contradictory explanations and evidence regarding the impact of trade on interstate relations?...To date, no compelling theoretical rationale has been offered for why empirical findings differ, other than the fact that scholars pursue very different inquiries, with different samples, data, measures or modeling techniques (1999, 399)

The final leg of the Kantian tripod—membership in a "federation" of states—has not received as much intellectual attention of late. Membership in international organizations and alliances has been statistically examined historically as a driver of international conflict and found to have a relationship (identified earlier in this chapter). Criticisms of this third leg typically come in the form of criticisms of global governance regimes.

A second type of criticism levied at the most parsimonious versions of Liberalism and Realism is that they do not sufficiently consider networks of states as key driving variables of state behavior. This criticism is, in a way, an extension of the criticism of the approaches for being overly parsimonious. In many ways, much of the thrust of IR in the

1980’s was oriented towards making both Realism and Liberalism more sophisticated, nuanced and empirically verifiable.

Looking at the drivers of either power or interdependence is not sufficient for a full picture of behavior within the international system. There are more complex forms of interdependence that can arise that cannot be explained by the standard versions of Liberalism and Realism. The ways in which states interact—their histories, their policies and their perception of one another—are all crucial driving variables of behavior of states in the international system. This second criticism does not yet embrace the next move towards culture and inter-subjective meaning making. It is an even more basic criticism of the main drivers of standard Liberalism and Realism.

Keohane and Nye provide an alternative to the three-legged version of Kantian Liberalism by promoting “complex interdependence” (1977). Three factors give rise to complex interdependence: linkage strategies; agenda setting; transnational and transgovernmental relations. These go beyond the standard, traditionally operationalized set of Liberal measures.

Snyder provides an improvement on Realist approaches to understanding state behavior by adding “process variables” (1996). Snyder’s goal is to increase the ability of neo-realism to explain things, while not doing too much damage to the parsimony promoted by Waltz. He does this by first parsing out “structural modifiers” which are systems in the international system that change the direct impact of structure on state behavior. These are the kinds of things that Nye is interested in his criticism of Realism by pointing to non-power incentives and the, “…ability to communicate and cooperate” (Snyder 1996, 168).

Eventually Snyder latches onto the important kind of intervening variable that can push forward the underlying logic of Realism without sacrificing excessive parsimony:

> "Relations or relationships are not behavior itself, but the situational context of behavior…Relationships lie between structure and interaction; they are the conduit through which structural effects are transmitted to behavior" (Snyder 1996, 172).

Relationships can be added to the structural realist account to make it more nuanced. Relationships also can provide the framework for analyzing "structural change", a common critique of Realist theory.

These are process variables. Process variables include alignments, conflicts, capabilities and interdependence. Interaction Arenas can also form process or relationship variables. Interaction can take place through preparedness, diplomacy and action (Snyder 1996).

For a third example of standard rationalist criticisms of Liberalism and Realism, see Schweller's *Balance of Threat* (Randall L. Schweller 2006). This account of Realism takes the logic of balance of power but does not apply it to all dyads. It is not solely the raw-power of the relationship (or relationships, as per broader alliances) that define the state behavior but the character of the relationship. If the relationship is characterized by animosity, then balancing behavior can occur. These modifications by Schweller are meant to improve, and not refute, Waltzian versions of IR (Schweller 1997).

The third kind of criticism that I highlight in this section is an extension of the first two: standard Realism and Liberalism do not sufficiently consider the role of norms, values and cultures in the behavior of states in the international system. Constructivism is an approach to doing IR that does not have the same substantive focus as either

Liberalism or Realism, in fact, it has many foci. It cannot be boiled down to univariate explanations. “Constructivism is characterized by an emphasis on the importance of normative as well as material structures, on the role of identity in shaping political action, and on the mutually constitutive relationship between agents and structures” (Reus-Smit 2009, 209). Earlier approaches to understanding behavior in the international system did flirt with the importance of the ideational structure of the international system. In many ways, this is a key component (if not a foundation) of Liberal accounts of behavior in the international system. However, the ideational components of Liberalism (and their child-theories, such as “complex interdependence” outlined above) made altogether different assumptions about actor behavior, typically being rationalist.

The notion that the world is a social construction appears obvious, at face. However, standard rationalist accounts of the field tend to gloss of this seemingly fundamental component of the human experience. The field of constructivism represents a partial (if not full) rejection of the rationalist project and instead an emphasis on the importance of the way that language is used and understood to shape action and behavior within the international system.

Constructivism gradually emerged as a separate method in the mid 1990s (though it has been a philosophic argument that has existed for much time before that) as an alternative pole in IR that emphasized the socially constructed character of relations in the international system. These authors intended to take rationalist accounts of IR and to show that they were actually only getting at a small piece of the actual puzzle in explaining how states behave.

Wendt writes prolifically in this vein. His Social Theory of International Politics is the closest to a decisive text deploying this method. There, Wendt argues for a socially constructed assessment of behavior in the international system, specifically around the role of anarchy. According to this account, anarchy is not a thing out there that is the fundamental deeper driver of behavior in the international system but is something that states react to (as identified most clearly in his "Anarchy is what states make of it" piece).

Wendt puts forward three "cultures of anarchy" that are meant to operate within the space that rationalists have typically identified as being one of the deep drivers of behavior in the international system. Cultures of anarchy are socially constructed spaces where states follow certain logics. For example, Wendt argues that we are currently experiencing a global Lockean culture of anarchy, which is characterized by rivalry. This rivalry is much different from the Hobbesian anarchy that had characterized state relations from the Peace of Westphalia until probably some-time after WWII (the Cold War?). Hobbesian anarchy is characterized by enmity. Wendt goes on to argue that there could be pockets of Kantian anarchy (characterized by cooperation) forming, and that the whole system is eventually moving in that direction.

Wendt also adds a second axis to his tripartite division between cultures of anarchy: the degree to which a specifically socially constructed space is internalized by different actors in the system. If the international system is structured according to a Kantian logic of anarchy, but this social construction is very thin, then the system will exhibit very different characteristics from a system where the Kantian anarchy is deeply embedded as the driving logic of behavior of states in the international system.

While Wendt's formulation of cultures of anarchy takes place at the level of analysis of the international system, they can be broken down to the level of bi-lateral relations. My approach to understanding the quality of relationships within the international system relies on evaluating the socially constructed character of relationships between states at a bi-lateral level. I am not concerned with how these bilateral relationships build to the level of the international system (at least not at this stage of my research) but instead on the possible kinds of relationships that can exist between states.

In terms of international conflict, the constructivist account is concerned with the role of language in the formation and shaping of behavior: if the international system is shaped by Kantian anarchy, then the likelihood of conflict will be different relative to various structural drivers than if the international system is shaped by Hobbesian anarchy.

Constructivist approaches tend to not emphasize rationalist, utility maximizing behavior in actors. Instead, they tend to be interested in the type of culture that dominates the system at a given point in time. Wendt most famously identified different types of international "cultures" that can guide behavior of states at any given time (Wendt 1992; 1999). States can be guided by a culture of Hobbesian (characterized by enmity), Lockean (characterized by rivalry) or Kantian (characterized by cooperation) anarchies. Each of these "cultures of anarchy" can be internalized to differing degrees.

While much of Wendt's criticism was levied at Realist accounts of international anarchy (as compared with domestic hierarchy) being the key deeper driver of state behavior, Wendt's approach also works as a criticism of standard Liberal accounts of deep drivers of behavior. Interdependence, just like anarchy, can involve different cultures that cause states to react very differently. Certainly interdependence leading up to WWI was treated differently than it is today. That is a product of both a structural and a cultural change in the international system.

IR Theory and Forecasting: Stocks and Flows

In Chapter 2 I argued that stocks and flows were important in conceptualizing and operationalizing dependent variables where continuity and change can be reasonably forecast over long time horizons. In that section the stocks and flows discussion was used to highlight underlying characteristics of variables that are forecast, such as GDP or population. The important stocks in these variables were capital and people, for example. These stocks and their related flows are the cornerstone of quantitative forecasts of Realism and Liberalism, but the conceptual framework of stocks and flows can also apply to the theoretical positions of the three perspectives that I have explored in this chapter.

Realism and Liberalism are neither stocks nor flows: they are substantive theoretical positions within the field of IR. The quantitative measures of Realism and Liberalism that I use as forecast indices rely on the modeling of their stocks and flows (discussed previously). This, however, is separate from thinking about how both substantive approaches interact with states using this same system framework.

Culture operates in international relations like a stock. It exists between pairs of states and helps to dictate how these states respond to external and internal shocks. This notion is clearly demonstrated in the literature on Enduring International Rivalries (Diehl and Goertz, 2000). Here, specific pairs of states have interactions characterized by stocks of conflictual culture. As with all stocks, it is difficult to move or change this intersubjectively held meaning rapidly, and some states (India and Pakistan, for example) find themselves embedded in poor relations for extended periods of time with little recourse for change.

The stock of culture operating in a dyad changes for various reasons, and it is not the job of this dissertation to fully evaluate that. It may be that both Realism and Liberalism impact the stock of culture and push it either towards more cooperation or more conflict. It may also be the case that the stock of culture mediates the way that Liberalism and Realism impact state interaction. Because each of the three perspectives that I have developed in this chapter are shown to explain more in conjunction than isolation (see Chapter 5) there are likely dynamics at play among states that can be further explored in later research projects.

Conclusion

The way in which Realism and Liberalism were described in this chapter was oriented towards a simple understanding of the core of these theoretical traditions. As I have used standard operationalization as my orienting point, and would argue that I am invested in treating these perspectives seriously.The third approach that I attempt to draw out from criticisms of both Liberalism and Realism is not a panacea nor do I believe that it represents a third substantive research agenda within the field. Instead it is an ambitious attempt to improve upon the historic operationalization of IR measures with sensitivity towards constructivist understandings of intersubjective meaning making, norms and cultures. I take this sensitivity—along with a limited understanding of the impact of this measure—and operationalize it in the next chapter.

5. Building the Model and Historical Performance

"Nearly everyone knows that correlation is not causation"
-*Michael Haas*[28]

Introduction

In this chapter I first create historic measures of both Liberal and Realist indices. Quantifying these indices lets us tell stories about the behavior of dyads in the international system. For example, some pairs of states experience high levels of relative material pressure (both states have about the same amount of guns, money and soldiers and are also in physical proximity or one member is a Great Power) but they may have more cordial relations because they tend to have very high levels of bilateral Liberalism. By measuring this over time, we can trace how the relationships between states have improved or deteriorated.

As argued in Chapter 4, traditional measures of both Realism and Liberalism have been criticized for being overly parsimonious, not treating complex interaction well and ignoring intersubjective norms, cultures and values. I present a third approach for

[28] (M. Haas 1974, 59)

measuring the behavior of states in the international system that I refer to as the Cultures of Interaction Index (CoI Index). This index is comprised of sub-indices that attempt to capture some aspect of a culture of complex state interdependence that is not apparent in either traditionally opearationalized measures of Liberalism or Realism. The limited goal of the CoI Index is to build upon previous IR measures, specifically by treating interdependencies—the core of Liberalism—in more depth. I leave the Liberal index as it has historically been operationalized[29] and attempt to add to this by producing a dyadic-first calculation of interaction between states that may capture some Constructivist notions of shared norms, cultures and language. The exact treatment of the CoI Index is outlined in more depth, below.

Together, it is hoped that these three indices together tell a more colorful story about international dyadic interaction.

Operationalizing complex theories with competing accounts is no trivial matter, and I make no claim to have *the* definitive quantification of IR. While quantification forces the theorist to make choices that exclude competing accounts, understanding the operationalization at a dyad-year may be particularly confusing. This takes us back to our discussion of levels of analysis in Chapter 2 where I was laying out the ground-work of identifying my dependent variable. The table below outlines the general operationalization of each index, drawing distinctions especially between the Liberal Index and the Cultures of Interaction Index.

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[29] I do not treat trade dyadically in the Liberal Index measure, as we do not have the capacity to forecast dyadic trade. I also augment the historic measure by including UN treaties as a component of international political system embeddedness.

Table 3: Overview of Operationalization of IR Theory

	Variables in Calculation	System Calculation	Dyadic Calculation	Conceptual Note
Dyadic Realist Index	GDP Population GDP per Capita Military Spending	Make index of total global material power by year. Divide each country total by global total and apply to politically relevant dyads.	In dyad take country with least power and divide it by country with most power.	This dyadic measure gets at the relative distribution of power in a relationship between two countries.
Dyadic Liberal Index	Democracy International Organizations UN Treaties Trade	Make index of the total engagement that one country has with the international system liberal measures.	In dyad take country with least global liberal engagement and divide it by country with most engagement	This dyadic measure gets at the relative commitment to global liberal norms (whether this indicates broader dyadic political affinity or not)
Cultures of Interaction Index	International Organizations UN Treaties Alliances Diplomatic Engagement	None	Measure interaction between both states in dyad for each of the sub-measures	By measuring dyadically this index rejects the notion that simple membership in an international organization or treaty is relevant decisions

	Distance			made in any given dyad. Instead, it argues for the characteristics of a "third way" promoted in Chapter 4: it is nuanced (calculating from the dyad-level up is a highly customized measure), it is networked (the number of shared IOs, for example) and it tries to get at intersubjective meaning (by taking a full and broad range of expected indicators of shared international political system affinity)
	Trade			

The Realist and Liberal measures that I create here have been used by other authors for quantitative analysis (see, for example Bennett and Stam 2000; and

Pevehouse and Russett 2006). The CoI Index, however, is created from the ground up, and is not entirely the same as other macro-level, global measures of state behavior in the international system. In some ways it builds upon previous measures, in other ways it attempts to break new ground.

Uniqueness does not necessarily correlate with utility. I therefore conduct a statistical test to explore whether the addition of the CoI Index in a combined IR Index can more accurately predict the occurrence of historic conflict than either Liberalism or Realism in isolation. If the CoI Index can be shown to add explanatory power to my index measures of Liberalism and Realism, then I argue that it should be considered to be an achievement in the field of quantifying IR theory. The CoI Index attempts to tell the story on a macro level across all country-dyad-years from 1960 that builds upon Realism and Liberalism as well as attempting to leverage aspects of criticism levied against these standard-bearers of IR. It attempts to break down the parsimony by treating cooperation in more complicated ways and hopefully pointing to a component of the culture of interaction between dyads. This approach endeavors to "get at" the same thing that Wendt identifies in his Cultures of Anarchy at a dyadic level and not a system level, while fully understanding that achieving a macro-level measure of cultural characteristics between two states is likely impossible.

This chapter outlines how the historic data were processed into a measure of dyadic threat of conflict and how this historic measure performs relative to the actual occurrence of historic conflict. While I do not expect a one-to-one relationship between the index and the actual occurrence of conflict (as noted in previous sections, the threat of international conflict is not the same as the actual occurrence of conflict), I do expect to see correlation. Also, this section will test one of the broader hypotheses of this project: do multiple IR Indices aggregated together identify conflict more accurately than more singularly focused approaches to measuring IR, such as Realism or Liberalism in isolation?

I proceed by first identifying how each sub-component was constructed, how the three indices were aggregated and then moves on to compare this with historic data. This analysis forms the backbone of later chapters that forecasts these relationships over time.

Building the Realist Index

For Realists, relative material power is the deep driver of the behavior of states. As outlined in Chapter 4, this stems from parsimonious assumptions about the “anarchic” structure of the international system. Beyond this sweeping conceptual consensus, there is less agreement on the operationalization of this school of thought.

In a general sense, the amount of Realist “pressure” across all pairs of states in the international system is the same, as they all operate in a milieu structured by anarchy and characterized by extreme uncertainty about future survival. If any state can be killed, all states operate from a basis of constant fear. Hobbes emphasizes this when describing human behavior in the state of nature. Even the weak can kill the strong when in, “…confederacy with others that are in the same danger with himself” (1914).

The variable that becomes instrumental—as described in detail in Chapter 3—is the relative distribution of material power. As the unit of analysis is dyad-year, this project is invested in measuring the amount of Realist pressure—as quantified by relative material power—on the every pair of countries where data is available.

I consider a dyad to be under Realist pressure if the distribution of material power is a salient component of decision-making in bilateral relations. We know that it is not true that all dyads experience the same amount of Realist pressure. Eritrea and Ethiopia make fundamental decisions about domestic investment and external alliances based—in large part—on the material resource distribution across borders. A range of enduring rivalries are under similar pressures. Ethiopia and Indonesia, however, do not make similar calculations when they interact in international groups and organizations.

Dyads experiencing Realist pressure—often referred to as "politically relevant dyads"—are those that are physically proximate and/or contain one member that is a Great Power (Lemke and Reed 2001). In these special relationships the relative distribution of material resources—and particularly how that distribution between the pair of countries is changing—is one of the components of diplomatic decision-making.

According to this measure—outlined in this section—countries with material power parity have high levels of Realist pressure, assuming that they are either physically proximate or one of the members is a Great Power. At first blush, this index most closely aligns within the Realist theory of power transition (Organski 1980). Power transition theory argues that the greatest degree of pressure on any dyadic relationship in the international system occurs when relative material power between the pair of states is most equal. This—as argued by Bennett and Stam (2000)—stands in sharp contrast to balance of power theory, which argues that power equivalence between countries is more likely to lead to pacific relations (Little 2007).

Both approaches' theoretical claims have been empirically validated. Bennett and Stam test the relative contribution of different IR theories to the actual occurrence of conflict. These authors find that, when politically relevant dyads are used to create a model that predicts the occurrence of war, both balance of power and power transition have explanatory significance. The bi-polar balance of power after WWII is one of the leading drivers of peace in this model. Power transition theory—with politically relevant dyads and the occurrence of conflict being the criterion—contribute positively to the occurrence of conflict.[30]

The dyadic Realist Index measures the degree to which relative material power considerations play a role in actual international relations. This is true for both balance of power theory and power transition theory, though with different ends. Power transition theory clearly makes the claim that the relative distribution of power factors into state decision making. The balance of power thesis also argues that the relative distribution of material power between a pair of states plays a paramount role in decision-making: both states must either build arms or alliances in order to maintain the balance, and thus preserve the peace. Thus, whether power transition theory or balance of power theory is empirically relevant the degree to which two politically relevant dyads share similar levels of material power is an important determinant of whether power plays an instrumental role in political decision-making, *ceteris paribus*.

The most widely used operationalization of relative material power in academia has been the Composite Index of National Capabilities (CINC) produced by the Correlates of War (Singer, Bremer, and Stuckey, John 1972; Singer 1988). The measure includes the relative country-level distribution of the following in the international

[30] Though power transition theory does not always positively contribute to the occurrence of conflict and is not a very impacting driver of either conflict or peace.

system for a given year: military expenditures, military personnel, steel production, energy consumption, urban population and total population (Singer and Stuckey, John 1972; Singer 1988).

The distribution for this variable across time for select Great Powers is shown in the line-graph below. The story that this graph tells are largely the great-power political history of the past two centuries. At the beginning of the 19th century, the UK was the dominant country vis-à-vis material power with over 30% of the world's resources. This situation of unilateral dominance gradually eroded and the US passed all other Great Powers at the beginning of the 20th century. The US remained the world's leading power until the early 1970s when it was passed by the Former Soviet Union. The US again vaulted to the position of Great Power in the international system at the end of the Cold War but was again passed by China before the 21st century began.

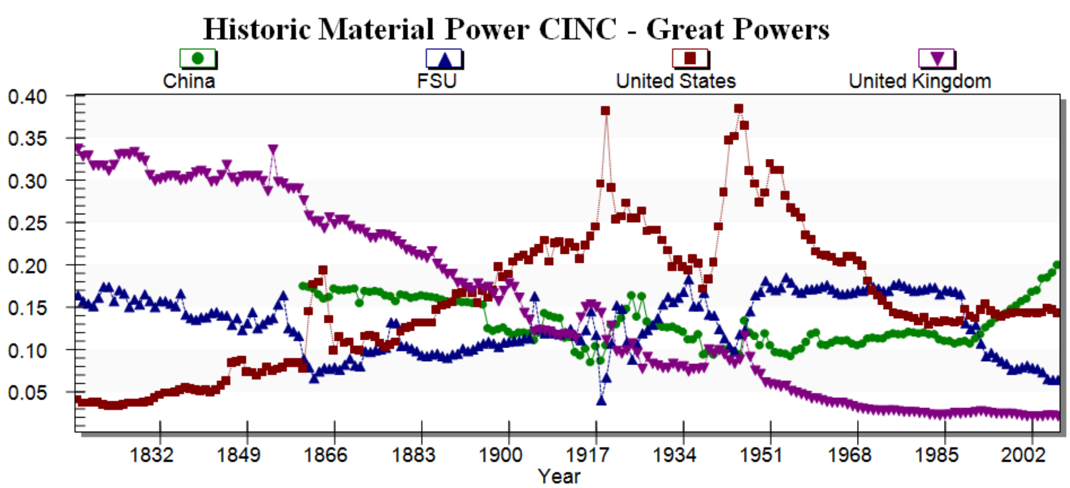

Figure 22: Historic Material Power CINC (v4.0) - Select Countries; Y-Axis Percent Material Power (Singer, Bremer, and Stuckey, John 1972)

This operationalization of material power seems to be more relevant for a world characterized by state interaction of the 19th and early 20th centuries, not the later stages of the Cold War and the 21st century. The index has been criticized for not adequately treating new membership in the international system (Kadera and Sorokin 2004) and generally overstating the relative power of the USSR and China (Chan 2005; Chan 2008; Tessman and Chan 2004).

Three of the six drivers of CINC are particularly problematic in a globalized world. Power projection now is very different from a world characterized by the great and capital-intensive wars that dominated the first 150 years of this measure. The inclusion of the size of urban populations is not a directly important determinate of power. Large urban populations may drive economic growth, which is widely argued to be a measure of national power, but the size of Manhattan—*ceteris paribus*—has a negligible impact on the ability of the United States to project influence.

Second, energy consumption is not an appropriate measure of global power for the 21st century. While energy consumption can be a good measure of overall economic output (as each unit of GDP requires a unit of energy to produce) it penalizes a country's level of power the greater their energy efficiency. Energy consumption may be included because it is a proxy for GDP and historic energy efficiency improvements were less dramatic. If GDP is the reason that energy consumption is included in the measure, it is still puzzling, as data on gross country output is available stretching back to the beginning of the 19th century (Maddison 2007).

Finally, the inclusion of domestic steel production clearly damages the current utility of the CINC measure. The fact that the US currently produces very little steel is an indication of the power of the US, not the weakness of the US. Steel production is relatively labor intensive. As labor is cheaper elsewhere, and the technology is relatively dispersed, the US produces little steel. A possible counter argument to this claim could be that steel production is required for any large-scale military endeavor and that the lack of production in the US indicates that this country is relatively less prepared for a military engagement. In a world characterized by globalization and technologically very advanced tools of war, the outsourcing of any component of a weapon is potentially harmful to security and not just steel. This issue was explored in depth by Brooks (2005).

A second historically opearationalized measure of material power is derived entirely from the size of naval power as one clear way that great-powers can project their influence. Modelski and Thompson draw a range of conclusions from the line-graph, below (1988 see Chapter 4 for a treatment of these conclusions; Rasler 1994 the line graph below is from this source, which took the original work from Modelski and added periods of Great Wars). The graph measures the percentage of naval power controlled by the hegemon at any given point in time and indicates the occurrence of great wars. The general conclusion is that periods of deconcentration in naval power lead to conflict.

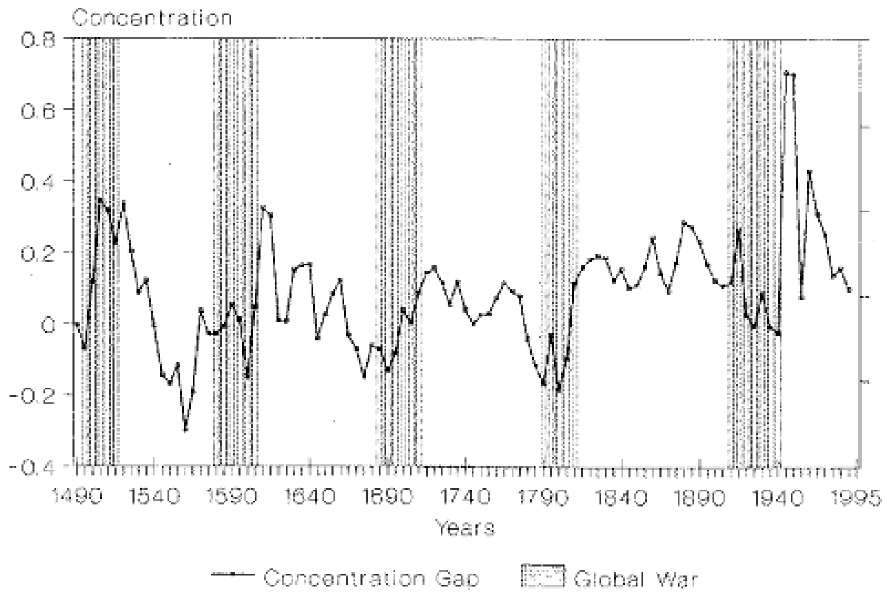

Figure 23: Great War and Deconcentration in Naval Power (Rasler 1994, 68)

This approach seems to "get at" something that occurs in the international community: wars appear to occur when concentration of naval power is relatively low. However, it is a small sample size (5 wars) and there is much variation in naval concentration where wars do not take place (the lowest point of naval concentration does not, in fact, correlate with war).

Alternative measures of relative national material power exist that are designed with the future in mind. The Strategic Assessment Group (SAG) created an alternative measure that uses, "…gross domestic product...,population, defense spending, and a less precise factor that includes innovation in technology" (Treverton and Jones 2005, 3)[31]. This series is operationalized within the IFs system and will represent the core of the forecast Realist Index (discussed in detail in Chapter 6). While the index is forecast

[31] This measure is not widely documented and the original creators of the index are not widely known. The following individuals should be attributed with credit: Paul Herman, Evan Hillebrand with Barry Hughes. The SAG was an organization within the CIA that has been more recently replaced by the Office of Transnational Issues (see below).

within IFs an historic longitudinal database of this measure of national power did not exist before this project.

A fourth measure has been developed out of the Office of Transnational Issues that is called the Global Power Index (GPI). It includes the following components: ICT Capital, R&D Spending, Governance Quality, Working Age Population Quality Adjusted, Foreign Aid, Foreign Direct Investment, Trade, Energy Imports-Exports, GDP, Military Spending and Nuclear Weapons (Treverton 2011). It is meant to capture a more varied account of power in the international system by including non-traditional measures.

Measuring relative national power is fraught with problems, and is an imprecise science. The fundamental problem with measures of power is that they have no dependent variable with which to compare and create a model of interacting independent variables. The "ability to get others to do what they otherwise would not have done" is not easily operationalized. Thus, power tends to be intuited. For example, when one of the original creators of the SAG measure of political power was asked about the different weightings assigned, s/he indicated that they used intuition and provided the example of the weight on the population component: if it was adjusted too high, Bangladesh become "too powerful".[32]

Material power is also temporally contextual (not to mention contextual in many other less macro ways as well). It thus becomes increasingly difficult to operationalize a measure that spans a long time horizon. As my analysis of the CINC index demonstrated, the types of variables useful for assessment in the 19th century are different from those

[32] This quote is taken from the author's personal experience in a Chatham House Rule workshop.

used during the Cold War and will be different from those that are useful in the long-term future.

In light of the discussion above, I created my own historic measure of relative power based on the work of the Strategic Assessment Group. The three other measures do not conform to my needs: the CINC measure does not conform to the current and future nature of power; naval hegemony is difficult to measure and is only useful for analysis involving great powers; the Global Power Index brings together both material and ideational drivers of power, something I prefer to separate for this project. The SAG measure was created to focus on material power and was created specifically with the IFs forecast system in mind.

The SAG relative national capabilities index takes country values relative to global totals for four variables: military spending, GDP at purchasing power parity, GDP multiplied by GDP per capita at purchasing power parity and population. The relative weight of each sub-index is identified in the bar graph below. GDP and population data were taken from the World Bank and the IFs system (Hughes 2004; World Bank. International Economics Dept. Development Data Group 2011). Military spending data was taken from the equivalent sub-measure produced for the CINC power index (Kadera and Sorokin 2004; Singer 1988; Singer and Stuckey, John 1972).

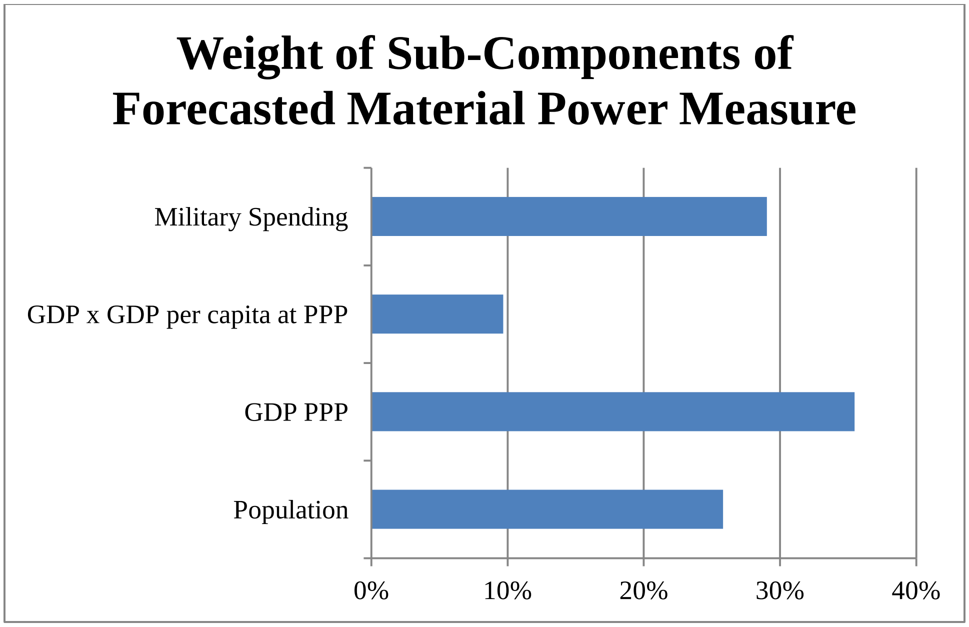

Figure 24: Relative Contribution of Sub-Measures of Relative National Material Capabilities

Data was gathered for each of the 183 countries in IFs.[33] For each year, country values were compared as percentages of the total for that given year. Thus, if a country had a population that was 1 billion and the total population was 5 billion, they would have 20% of the global population. These annual percentage values were calculated for each of the values in the previous paragraph. Weights were applied to these four values taken from the SAG assessment. The equation for calculation national level material power is shown below.

$$Power_{Country\ A} = \left(\frac{Military\ Spending_{Country\ A}}{Military\ Spending_{World}}\right) * 0.29 + \left(\frac{GDP * GDP\ per\ capita\ at\ PPP_{Country\ A}}{GDP * GDP\ per\ capita\ at\ PPP_{World}}\right) * 0.1 + \left(\frac{GDP\ PPP_{Country\ A}}{GDP\ PPP_{World}}\right) * 0.35 + \left(\frac{Population_{Country\ A}}{Population_{World}}\right) * 0.26$$

The US has by far the largest GDP in this time period at both market exchange rates and purchasing power parity. For military spending, the US and Former Soviet

[33] Again, see Appendix 1 for those countries

Union have similar and increasing levels of spending up to the end of the Cold War, then growth in US spending flattens, and Soviet spending falls significantly. US military spending then increases significantly in the late 1990s and through the beginning of the 21st century. The term that captures a synthesis of technology and size is operationalized by multiplying GDP at market exchange rates with GDP per capita at purchasing power parity. The overall size of GDP at market exchange rates indicates how much can be purchased by a country on international markets. The size of GDP per capita at purchasing power parity is a standard measure of human development in a country (though far from perfect). Historically, the US and Japan have dominated this measure with 16% and 22% of global GDP * GDP per capita at purchasing power parity at the turn of the century. The top five in 2000 are all large advanced economies: Japan, United States, Germany, United Kingdom and France. China has the largest global population—a measure of the total amount of people at its disposal—with 20%. This is followed by India (17%), the USA (4.6%), Indonesia (3.4%) and Brazil (2.8%).

The figure below shows the distribution of relative power for China, India, Russia and the US. In 1960 the US held nearly 27% of the world's material power. This declined to below 20% by the mid to late 1970s and has remained near this level until the beginning of the 21st Century. China and India, on the other hand, have seen their relative material power slowly and steadily increase across time from 7% and 5%, respectively, to 10% and 6%. Russian power starts above 10% of global power and remains there until the end of the Cold War, when military spending was constricted considerably. Russian power may intuitively seem low to readers, but remember that this measure does not consider nuclear weapons (one main driver of Cold War power measures) and it is just measuring Russian power, not the full Former Soviet Union.

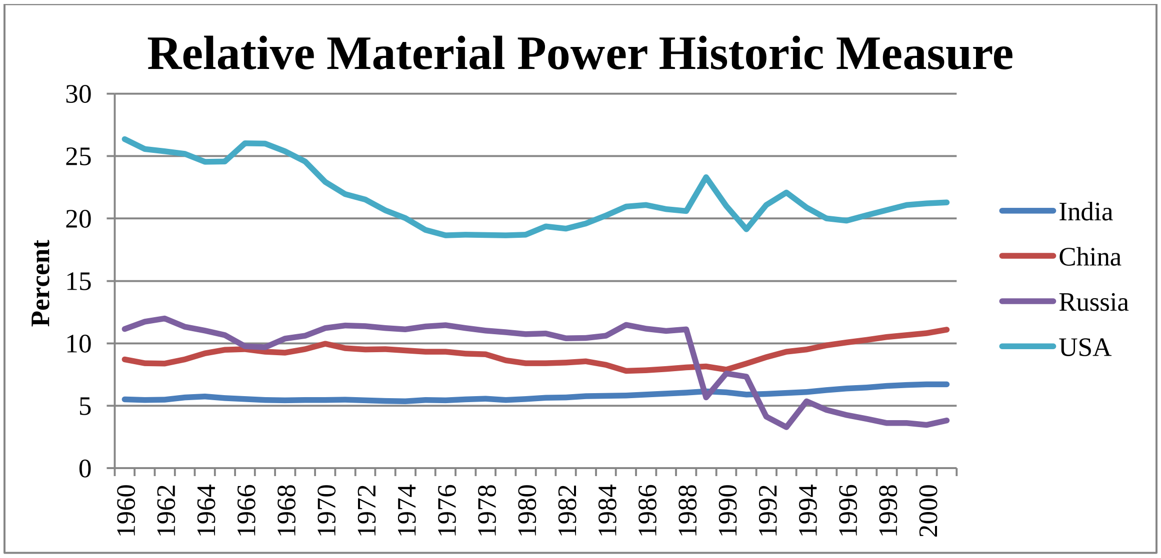

Figure 25: Relative Material Power Historic Measure - Author Creation from Various Sources using Herman-Hillebrand Method (Treverton 2011; Treverton and Jones 2005)

This project is invested in exploring relationships between states. The country-year data that I created above is not sufficient for this exploration. Thus, I take country-year data and transform it into dyad-year data. Conceptually, I am interested in a measure that can tell me the degree to which material power considerations play into policy making decisions. Operationally, I create an algorithm that first identifies whether the pair of countries is politically relevant and secondly how much proximity there is in the distribution of power across the dyad. Formally, the algorithm is displayed below.

IF

$Power_{Country_A}$ > 2% OR

$Power_{Country_B}$ > 2% OR

$Country_A + Country_B$ = Shared Territory

THEN

IF

$Power_{Country_A} > Power_{Country_B}$

THEN

Dyadic Realist Index $\text{Score}_{Country\ AB} = Power_{Country_B} / Power_{Country_A}$

ELSE

Dyadic Realist Index $\text{Score}_{Country\ AB} = Power_{Country_A} / Power_{Country_B}$

The index is then inverted and standardized.[34] This brings the valence of the Realist Index in line with the Liberal and Cultures of Interaction indices. In those measures, absolutely higher values indicate an improved character of relations between states. We also want high values to indicate more passive relations for the Realist Index so combination is not problematic.

If country-year measures of relative material power are problematic—for the reasons mentioned above—dyadic measures of historic material power meant to represent actual pressure on a relationship are even more complicated. These macro-level-level-measures-turned-dyadic miss much nuance, especially potential Realist pressures that would change a relationship's dynamics over the short run.

The distribution of the Realist Index, across all dyad-years, is shown the vertical histogram, below. Higher values indicate lower levels of Realist Index pressure on the relationship. In other words, theoretically we would expect these relationships to be less concerned with relative material power build-up, *ceteris paribus*.

[34] Standardizing is a process of making different data-sets comparable by subtracting each individual value in the data set by the mean of the entire data set and dividing by the standard deviation for the entire data set. The output of standardization can be understood as the number of standard deviations above and below the entire sample mean.

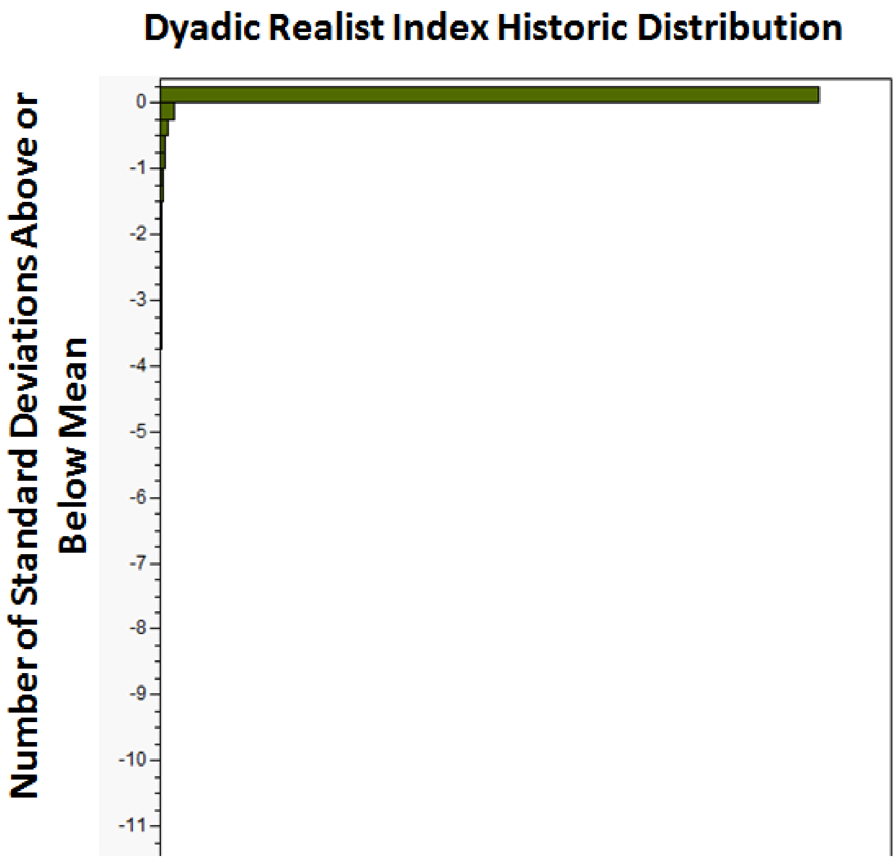

Figure 26: Histogram Measuring Distribution of Dyadic Realist Index. Y Axis is number of Standard Deviations Above or Below Mean

This distribution is radically different from the Liberal Index shown later in this chapter. Here, the majority of dyad years—85.3% of all dyad years—lie at the top of the distribution (with a standardized value of 0.198), indicating that there is no Realist Pressure in operation and that the dyad is not politically relevant. More concretely, this indicates that the large majority of country pairs do not actively consider relative material power levels and shifts in their one-on-one diplomatic decision-making with one another.[35] The very long, thin tail that falls below the distribution reflects the wide range of Realist Pressures that can exist between dyads that are territorially contiguous or that have one Great Power in the dyad.

The Dyadic Realist Index measures relationships longitudinally. Any value below 0.198 represents a politically relevant dyad, which means that relative material power is more likely to figure into the decision making process as compared with other dyads. As the vertical histogram above indicates, values can range from 0.198 to as low as -11.

The line-graph below shows three Dyadic Realist Index scores across time. The blue line Dyadic Realist Index score is for Russia and the USA, which begins at around -4.5 and becomes more negative (indicating an increase in pressure) out towards the end of the Cold War. Reductions in military spending help to reduce pressure between the two countries through the 1990s. The red line in this graph shows the Realist pressure between North and South Korea over time. It argues that the material pressure between these states has declined over time, mainly due to the massive growth in South Korea and the inability for North Korea to catch up. The green line is the power distribution between Iran and Iraq, with a notable increase in pressure during the 1980s and a decline after Gulf War I.

[35] They may consider material power in their extended diplomatic engagement, but this dissertation does not map extended alliance networks. See the Conclusion for a treatment of research next-steps, which include alliance treatment in quantitative models that build upon the work done in this dissertation.

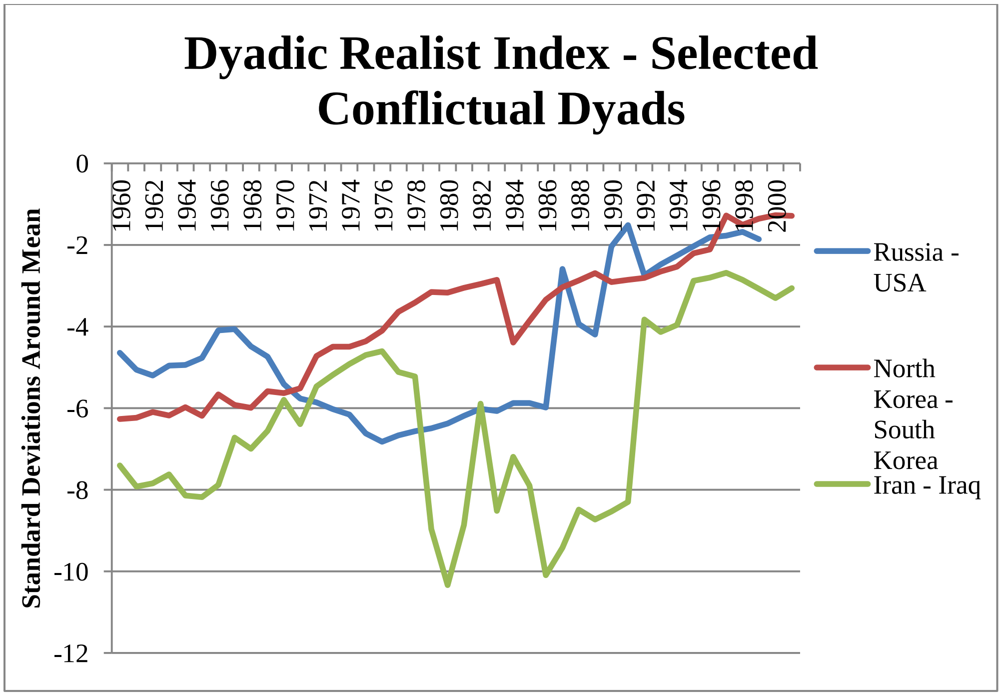

Figure 27: Dyadic Realist Index: Selected Dyads

Dyad specific longitudinal trends reflect political relevance and relative material power distribution. Dyad measures can be aggregated and averaged to reflect broader group Realist Pressure across time as well. For example, all of the dyadic relationships for one country can be averaged. This provides a quantitative measure of the total amount of Realist Pressure for a given country or group.

Creating group averages for Realist Pressure across this historic time horizon shows a general and sustained move towards less overall pressure; this would indicate that—overall—relative material power is becoming a less important component of dyadic decision-making. However, grouped longitudinal trends can be misleading. The number of dyadic observations per year increases across this entire time horizon (from around 5000 observations in 1960 to nearly 16,000 observations by the turn of the century). This increase in dyads reduces the overall average Realist Pressure measure, as the addition of new states brings relatively more dyads that lack political relevance.

The line-graph below only includes states in the Realist Index that existed in 1960. This shows a more plausible Realist account of the distribution of pressure across time. According to Realist accounts, without global hierarchy there will always be dyads in the international system that are forced to use the logic of relative material power gains to make decisions. The longitudinal distribution of this pressure should be random, with increases in pressure as the global distribution of power becomes more egalitarian and decreases in pressure as the distribution of power becomes more asymmetrical. This line-graph confirms the Realist assumption that relative material power considerations have played a consistent role in state decision-making across this time horizon. Instead of pressure dissipating across the time horizon, the index below shows a gradual decline up to the end of the Cold War and then an increase in pressure for this grouping of states.

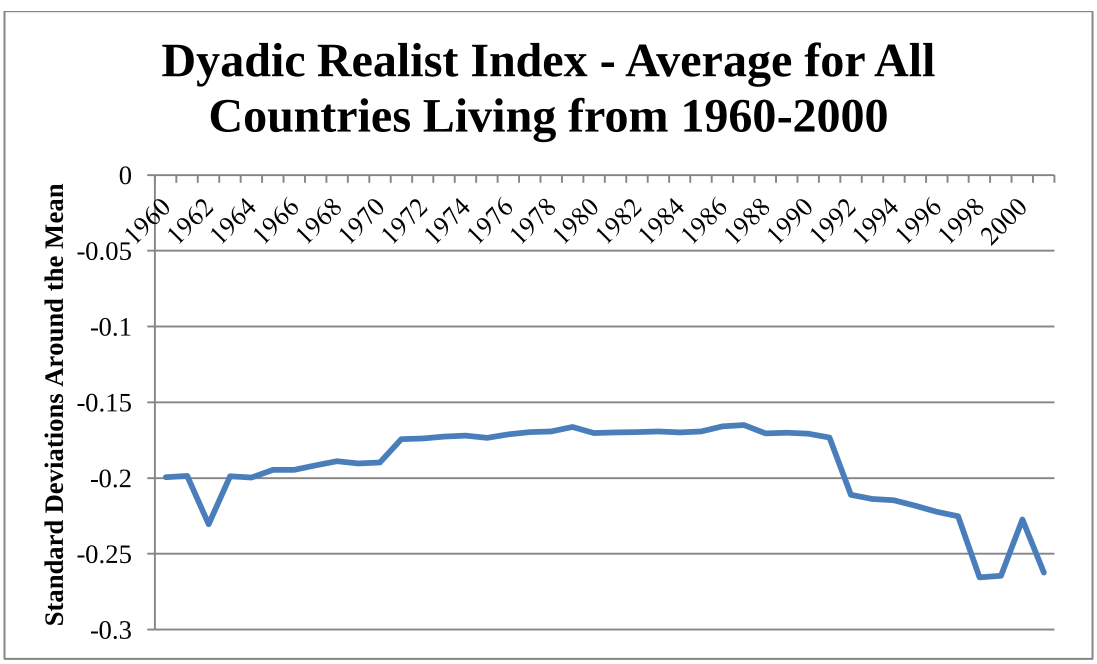

Figure 28: Dyadic Realist Index: Average for All Historic Living Countries from 1960-2000

It is the hypothesis of this chapter that the sub-components of IR theory explain more in conjunction than they do in isolation. The Dyadic Realist Index—while "getting at" some behavior in the international system—does not explain all dyadic behavior between states. The line-graph below provides an example of this, and is a bridge towards the next section that builds the Dyadic Liberal Index. Here we see three dyadic relationships—between Belgium and the Netherlands, Japan and the USA, and France and the UK—where relative material power calculi should be at the forefront of their decision-making.[36] Instead, these three dyads all experience pacific relations that can hardly be characterized by relative material power considerations. There are clearly other explanatory variables at play that must be evaluated, and we turn to these in the following sections.

[36] Though it may be interesting to note that there have been historic tensions between the US and Japan along with the UK and France.

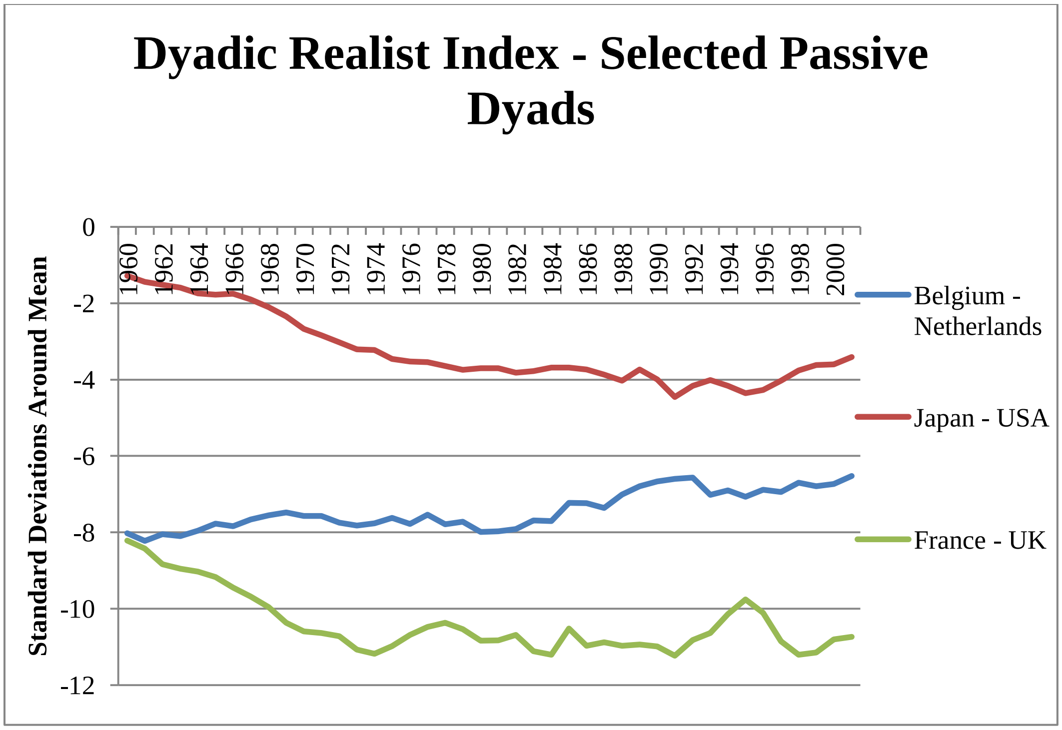

Figure 29: Dyadic Realist Index Select Passive Dyads

Building the Liberal Index

The Dyadic Liberal Index measures the degree to which two countries share traditional values that are thought to impact interdependence and is influenced from the writing of Immanual Kant (1991). Kant wrote about three key components of a lasting and perpetual peace: trade, democracy and a commitment to international organizations. The measures of Liberalism have been widely operationalized at a national level (Russett, Oneal, and Davis 1998), though I make some important conceptual improvements on the treatment of embeddedness in international political organizations. I repeat this country-level operationalization and then turn this into a dyad-year measure of the shared level of Liberalism.

Conceptually, the Dyadic Liberal Index used in this project measures the degree to which two countries are driven by interdependencies at a *global level*. This is not how Liberalism is always treated conceptually, and even operationally. I treat Liberalism in this way because I want to forecast it in IFs to 2050. We do not have the capability to forecast dyadic levels of trade on a global basis—the variable that is most frequently operationalized on the basis of dyads in studies of Liberalism—but we can forecast trade between one country and the rest of the world. This constraint, along with the fact that Liberalism has been operationalized along these lines previously, points to my logic of choice. The dyadic operationalization of the Liberal Index is a measure of states' global involvement in systems that are meant to foster interdependence and promote a lasting peace. They are not dyadic measures of policy alignment, diplomatic connection or the degree to which the two countries in question enjoy positive relations.

An additional concern may arise that I am also changing the historic operationalization of Liberalism by including a measure of treaty signings and ratifications to the measure of international organizations. Typical measures only include global membership in IGOs and do not treat treaty membership. I have added treaty membership for two reasons. First, it is a new data set that I am bringing to the field that has conceptual consistency with the third leg of the Kantian tripod. Second, this is a choice made in the interest of creating a long-term forecast. We cannot forecast events like the signing of a treaty or the admission to an IGO of a given country. Instead of relying on these events that appear to be discrete at our level of analysis, aggregating across measures produces an overall index that can be more easily forecast.

I begin—as I did with the Dyadic Realist Index—by constructing the Dyadic Liberal Index at a country-level. This requires building three, equally weighted parts: democracy, trade and embeddedness in international political organizations. I then take this country-year index and turn it into a dyad-year index by adding up the total Liberalism for the dyad-year and dividing by the total possible Liberalism for the most liberal dyad-year in my sample. This creates an index. To remain consistent with my operationalization of the Dyadic Realist Index, I standardize this index. This process is explained below and the behavior of each sub-measure is explored. The equation below is the underlying logic of the index. Variables with sub-script "threshold" are the upper or lower limits across the entire historic data set for the outlier country.

$$\mathit{Liberal\ Index\ Score}_{Country\ A} = ((\mathit{Democracy}_{Country\ A} / \mathit{Relative\ Democracy\ Importance}_{Threshold}) + (((\mathit{Imports}_{Country\ A} + \mathit{Exports}_{Country\ A}) / \mathit{GDP}_{Country\ A}) + (\mathit{Imports}_{Country\ A} + \mathit{Exports}_{Country\ A})) / \mathit{Relative\ Trade\ Importance}_{Threshold}) + ((\mathit{IGO\ Membership}_{Country\ A} / \mathit{IGO\ Membership}_{Threshold}) / ((\mathit{Treaty\ Ratification}_{Country\ A} * 2) / \mathit{Treaty\ Ratification}_{Threshold})) / (\mathit{Treaty\ Signing}_{Threshold} / \mathit{Treaty\ Signing}_{Threshold})) \mathit{Treaty\ Overall}_{Threshold}) / \mathit{Relative\ International\ Political\ Embeddedness\ Importance}_{Threshold}) / \mathit{Liberal\ Index\ Score}_{Threshold}$$

Historically, the sub-components of the Liberal Index grew rapidly, and mostly after the end of the Cold War. Global exports as a percentage of GDP have experienced accelerated growth since 1965. They increased from about 10% in 1965 to about 20% by the mid 1990's. Since then levels have increased to nearly 30% of total GDP. Global democracy (as measured by Polity) actually declined from the 1960s to the late 1970s and then experienced a rebound to levels seen in the early 1960s. The end of the Cold War caused democracy levels to spike—over a 55% increase—from 1989 to 2010. Embeddedness in International Political systems—the measure identified as being comprised of UN Treaties and IO memberships across time—has grown rapidly and consistently across time, especially after 1989. The sections below elaborate on this, but focus much of their attention on the measure of embeddedness in the international political system, a relatively unfamiliar measure. The historic behavior of trade and democracy have been thoroughly documented (Huntington 1984; Kindleberger 1975).

Embeddedness in International Political Systems

The first component of the index was a measure of commitment to the international system through membership in international organizations and UN treaties. These are the same values used in the creation of the Cultures of Interaction Index, described below, but operationalized differently. Instead of being measured initially on a bilateral basis, these were measured single country commitments to treaties and international organizations in the international system. In other words, instead of measuring how many treaties and international organizations a pair of countries shared membership in, this measure explored the total number of international organizations and treaties that a country participated in.

The international organization data was taken from the Correlates of War project (Correlates of War Project 2008; Pevehouse, Nordstrom, and Warnke 2004). The country-year number of memberships in international organizations was summed. An index was then created using the highest total value of international organization membership as the upper threshold (1) and the lowest number as the lowest threshold. The second component of this measure was the total number of UN treaties that a country had signed or ratified across time (United Nations 2011). If a country signed a treaty this was scored as a 1. If they ratified a treaty, this was scored as a 2. The total number for each country-year were added up and an index was created with the upper value scored as a 1 and the lowest value scored as a 0 with all other values scaled within that range. These two sub-indices (the IGO membership and the UN Treaty data) were then averaged. The historic performance of this measure is shown in the line-graph below.

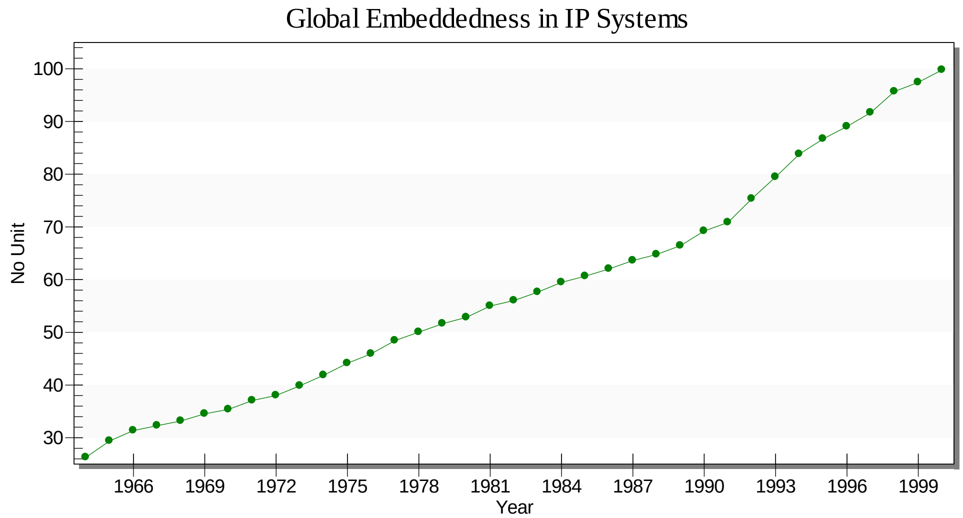

Figure 30: Average Country-Level Embeddedness in International Organizations and UN Treaties Across Time. The Y Axis is a composite score that equally weights membership in IOs and UN Treaties, and doubly weights ratified treaties over signed treaties.

Data on longitudinal country membership in international organizations is kept by two organizations.[37] The first, and perhaps most well known, is the data gathering work of the Correlates of War Project. Originally this data was organized by Wallace and Singer (1970). Current versions of this series are managed by Pevehouse, Nordstrom and Warnke (2004). This group has collected data on an annual basis from 1815-2000. The Center for Systemic Peace collects a data series in membership in conventional intergovernmental organizations on a 5 year interval from 1952-1997 (M. G. Marshall,

[37] The Union of International Associations is also a database for IGOs, INGOs and other civil society actors, but is not broken down longitudinally on a country-basis. See here (Union of International Associations 2001)

Marshall, and Young 1999). These data sets are plotted against each other in the graph below for the average number of memberships per country in the international system for the full breadth of data available. Both of these data sources are comprehensive in their country coverage, but the Correlates of War data has a more extensive temporal coverage. Both measures also seem to be getting at the same thing, as they have similar trajectories and slopes.

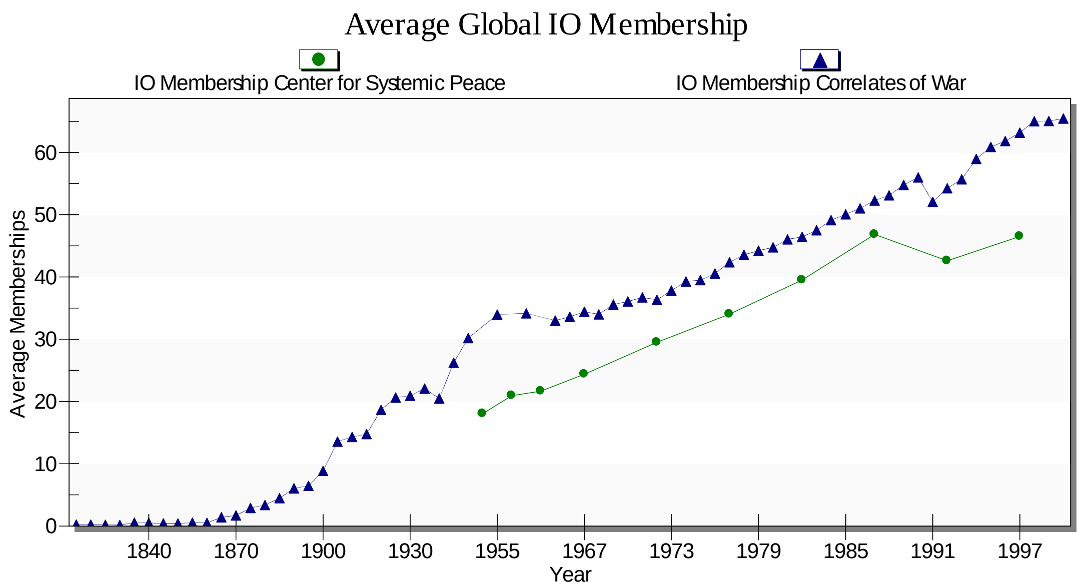

Figure 31: Average Number of IO Memberships per Country – History (M. G. Marshall, Marshall, and Young 1999; Pevehouse, Nordstrom, and Warnke 2004)

Overall, membership in international organizations has increased throughout the 20th century. There are notable exceptions to this. Two periods of stagnation in the increase in membership occur around World War I and II. The next two periods of negative growth or stagnant growth occur when state membership in the international system increased relatively rapidly as the institution of colonialism fell in the late 1950s, and again at the end of the Cold War. Adding new states to the international system that begin with low IO membership pulls the global average down.

The figure below shows membership in international organizations for the Correlates of War database by UN population regions. Again, the trend demonstrates strong and consistent growth across time. Notably, rich Western countries have higher levels of embeddedness within international organizations throughout this time horizon, with Asian, African and Latin American countries generally having less overall embeddedness. Again, similar trends identified above can be seen in more detail, most notably the end of the Cold War and the increase in states in Europe and Asia reducing average membership.

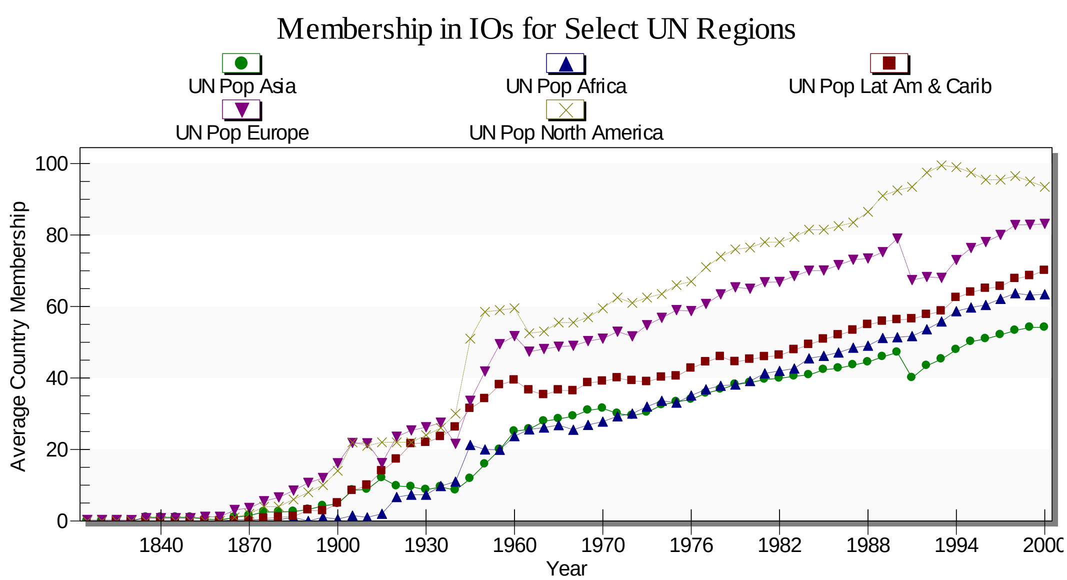

Figure 32: Membership in IOs for UN Regions (Pevehouse, Nordstrom, and Warnke 2004)

Membership in international organizations has long been the measure of choice in exploring country embeddedness in international political systems[38]. UN treaties have been generally overlooked. The database on UN treaties is freely available online

[38] See a wide range of studies for this, including but not limited to: (Boehmer, Gartzke, and Nordstrom 2004; Dorussen and Ward 2008; Pevehouse and Russett 2006; Oneal, Russett, and Berbaum 2003; Russett, Oneal, and Davis 1998; Russett 2001)).

(http://treaties.un.org/Home.aspx) and identifies the dates when countries either signed or ratified treaties held by the Secretary General (United Nations 2011). The information is not in an easily accessible form for macro-level analysis.

For this project, the UN Treaty information provided online was converted into an accessible database. The countries where data was pulled were the 183 included in the IFs system (See Appendix 1 for a list of these countries). Data was coded in two ways. First, if a country signed *or* ratified a UN treaty in a given year, they were given a coding of 1. These were then added up for each year from the end of WWII to 2010. Second, if a country signed a treaty in a given year this was coded as 1, and if they ratified a treaty, this was coded as 2. This second coding is used to forecast the index of IO embeddedness. While it is arbitrary to claim that a ratified UN treaty is worth twice as much as a signed UN treaty, there clearly should be a difference in weight between the two acts. The global distribution of UN Treaty signatories is shown below. Two things become apparent. First, there are two kinds of growth patterns. The slope of the global average membership in UN treaties after WWII indicates that the global average score was increasing at a fairly steady rate of around 220 points per year (that represents a combination of signing and ratifying treaties, and could represent 110 ratified treaties, 220 signed treaties or a combination therein). After the end of the Cold War, the rate of increase in signing and ratifying UN treaties increased substantially. Here, the average global score increases by over 800 points per year. This is due to a large number of new countries, mostly in Europe, that eagerly embedded themselves in the UN process.

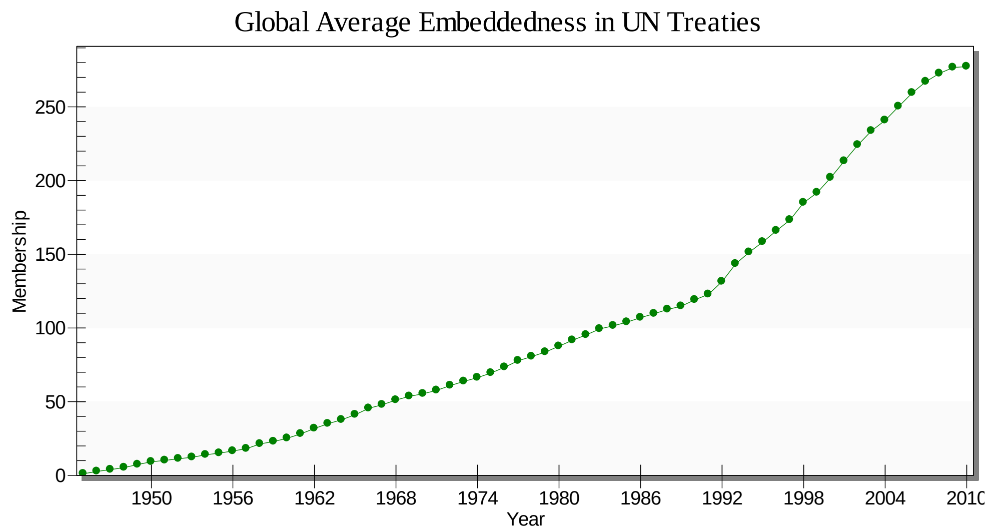

Figure 33: Composite Measure of Embeddedness in UN Treaties (United Nations 2011 with author manipulation)

The UN data was also broken down by category. The categories are identified in Appendix 2. For the graph below, UN Treaties were divided into Domestic Security, Economic, Environmental, Human Rights and Military. The global average score indicates that Economic, Human Rights and Environmental treaties have grown at increasing rates increase about the end of the cold war. Military related treaties remain quite low, and domestic security treaties have seen very limited growth for the entire time horizon.

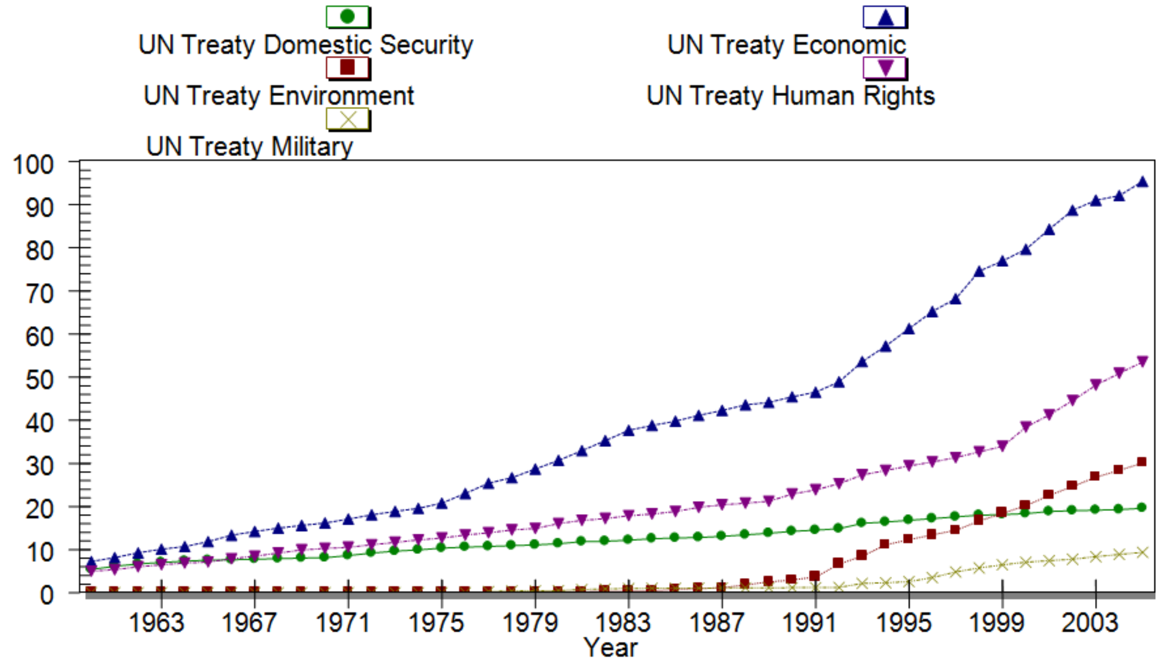

Figure 34: United Nations Treaties for Selected Categories (United Nations 2011 with author manipulation)

Democracy

The next component of the liberal index was a measure of governance inclusion taken from the Polity database project (M. G. Marshall and Jaggers 2009). The values of this data measured democracy across time on an 11 point scale (0-10, with higher values representing more democracy). This was re-scaled so that scores of 10 were given a value of 1, and scores of 0 were given a value of 0 with all other values scaled within this range.

Historic change in democracy levels has produced three “waves”, an idea popularized by Samuel Huntington (Huntington 1984). The first wave occurred after WWI. The second after WWII and the de-colonial process. The third occurred at the end of the Cold War. These transitions are represented in the line-graph below. The data on democracy has a much longer time horizon than most series, stretching back to the early 19th century.

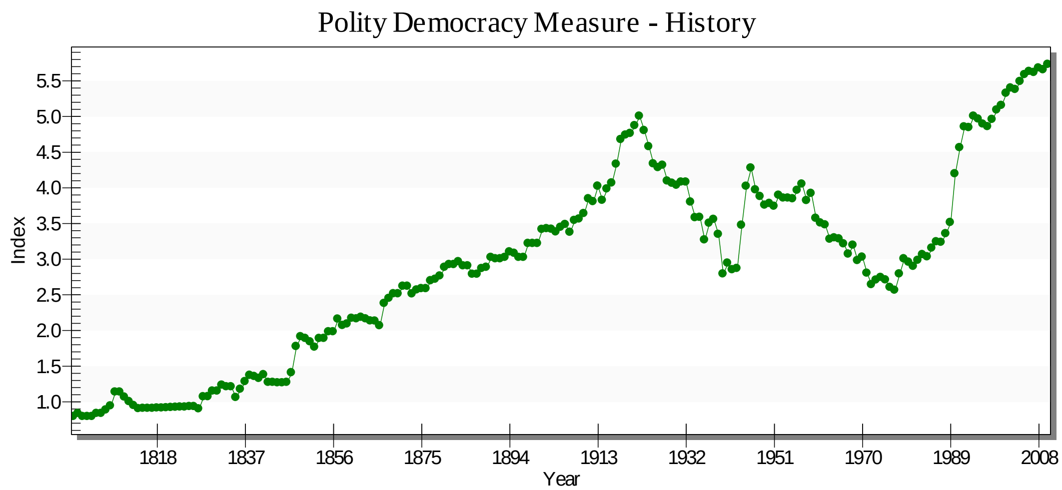

Figure 35: Polity Project Democracy Measure – History (M. G. Marshall and Jaggers 2009)

Data clearly indicate that global average democracy levels have experienced three clear transitions[39]. However, broken down into UN population divisions, this shift has been far from even. North America and Oceana remain fairly consistently high (with the later experiencing a decline in the post-colonial period). Levels of democracy follow the three waves of Huntington in Europe, but the pattern is less clear in other regions. Latin America grows democratically in the post-colonial period, but even more strongly as the Cold War comes to an end. Asia grows right around the end of WWII and only rebounds at the end of the Cold War. Finally, African democracy remains relatively low, growing not in the de-colonial period, but up to the level of Asia by the end of the Cold War.

[39] Huntington's work is not without its detractors. See Doorenspleet for a review (2000).

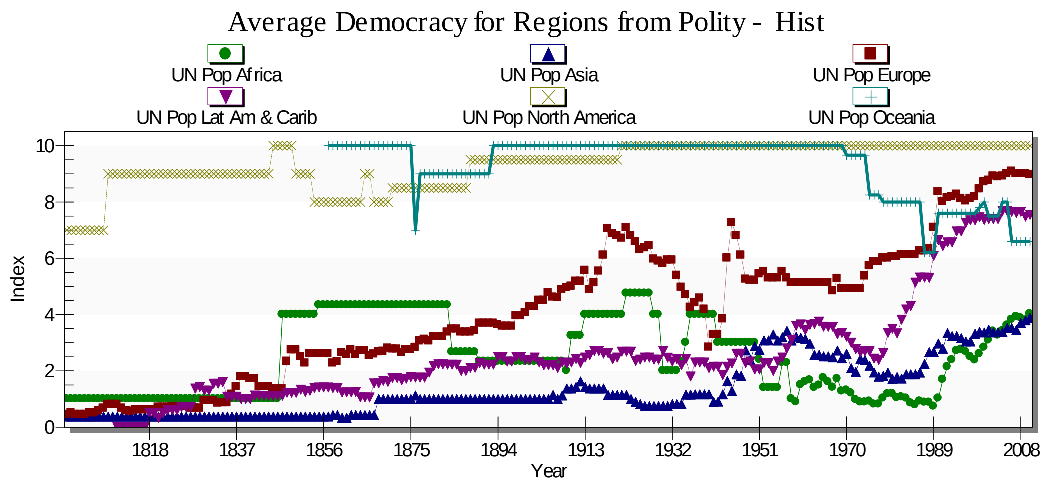

Figure 36: Average Democracy for UN Population Groupings – History (M. G. Marshall and Jaggers 2009)

Vis-à-vis governance inclusion, the overall historic trend has been up. This seems to be likely to continue, as countries with large democratic deficits[40] have experienced democratic transitions since the beginning of 2011 with the Arab Spring and the prospects for a more inclusive governance regime emerging appears strong.

Trade

The third element is a measure of a country level commitment to trade. This was taken as an equal weighting of a country's total trade levels and their imports and exports as a percentage of GDP. Both absolute trade levels and trade levels relative to GDP were taken from the World Bank's World Development Indicators database (2011). Absolute trade levels were taken and an index from 0-1 was created using the lowest and highest values available across time in the dataset. The relative trade levels were taken by first adding up total exports and imports and dividing them by GDP (at market exchange rates). Total trade as a percentage of GDP was then taken and an index was created using

[40] A measure of the relationship between actual levels of democracy and expected levels, based on a basket of human development indicators.

the highest and lowest values across the entire time horizon (from 1960 to 2001[41]). These absolute and relative trade values were then averaged.

As the line-graph below demonstrates, global exports as a percentage of GDP have increased at a fairly consistent rate across time. Starting in the 1960s with just over 12% of GDP being attributed to exports, the quantity of goods and services crossing borders had increased by nearly 2.5 times before the impact of the Great Recession was felt. This increase in trade has been attributed to many factors

Figure 37: Global Exports as a Percentage of GDP – History

The three components of the liberal index were taken and averaged. If there were nulls in any of the sub-components then the remaining components were averaged (so, if a country was missing data on democracy but had data on trade and international organizations/treaties, the latter two components were averaged).

Dyadic Liberal Index

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[41] There is dyadic data for trade and democracies beyond 2001 but I choose not to use it. There was not data for IO membership after 2001, and this is a key component of both the Liberal Index and the CoI Index. Thus, all historic data analysis stops at 2001. Further work on this project would extend the historic data base.

The Dyadic Liberal Index was created by taking the country-level Liberal Index score for each pair of countries across time for each given year and finding the upper and lower bounds. The pair of countries that were the most liberal in this index measure was Germany and the Netherlands in 2001 (with a standardized score of 3.9). The least liberal pair of countries was North Korea and Tanzania in 1961 (with a standardized score of -1.7). These two values were then used to scale all results from 0-1. This index was then standardized to reflect the distribution of the values in the same way that the Dyadic Realist Index was created. The logic of the creation of the Dyadic Liberal Index is shown below.

IF

$$Liberal\ Index\ Score_{Country\ A} > Liberal\ Index\ Score_{Country\ B}$$

THEN

$$Dyadic\ Liberal\ Index\ Score_{Country\ A\ B} = Liberal\ Index\ Score_{Country\ B} / Liberal\ Index\ Score_{Country\ A}$$

ELSE

$$Dyadic\ Liberal\ Index\ Score_{Country\ A\ B} = Liberal\ Index\ Score_{Country\ A} / Liberal\ Index\ Score_{Country\ B}$$

Below is the vertical histogram of the Dyadic Liberal Index for all dyad-years. It demonstrates two peaks, one above the mean and one below the mean. This indicates that—between 1960 and 2001—the lion’s share of dyads in the international system are either slightly liberal (as this peak occurs just north of the distribution mean) or fairly non-liberal (as this peak happens at a full standard deviation below the mean). The shape of the historgram for the Dyadic Liberal Index has shifted across time. Historically the two peaks were more pronounced (representing the two major alliances during the Cold War) to a distribution in 2001 that is much more bell-shaped. The distribution of the Dyadic Liberal Index is much more “normal” than the Dyadic Realist Index.

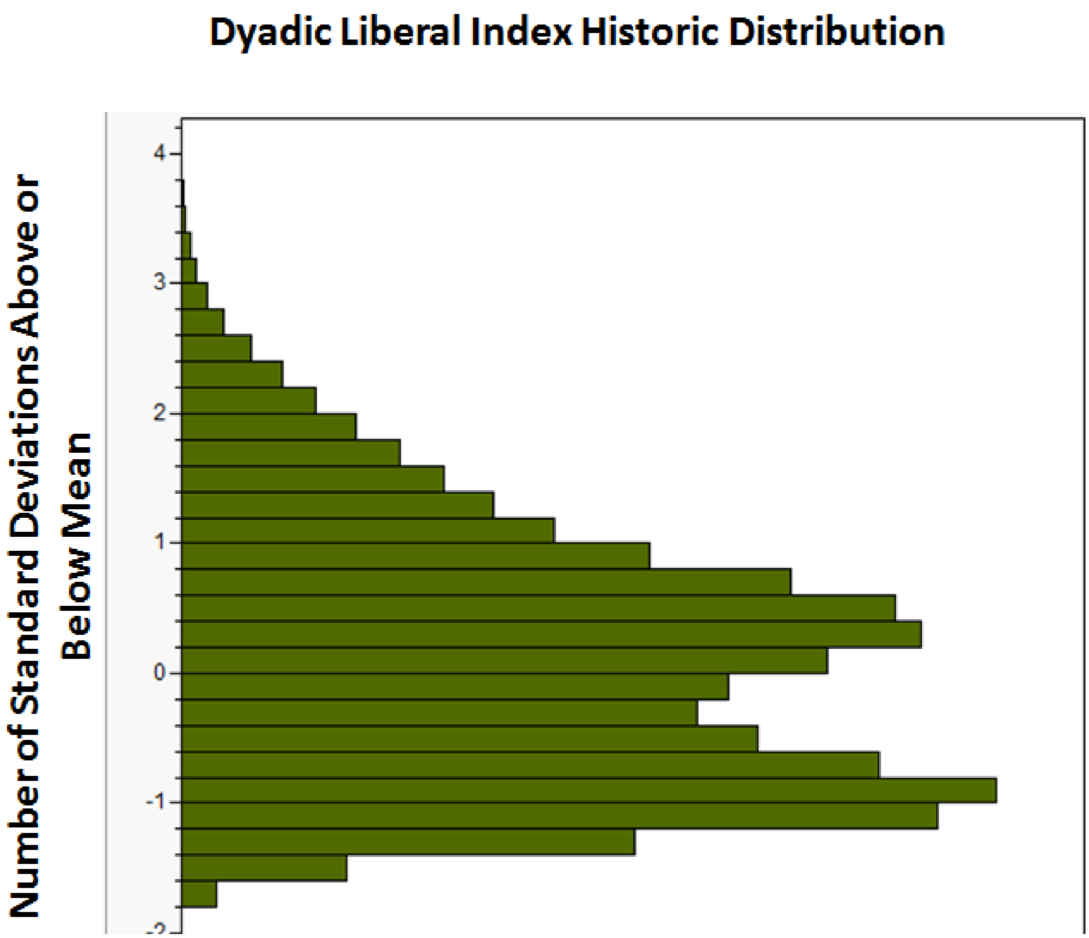

Figure 38: Histogram Measuring Distribution of Dyadic Liberal Index. Y Axis is number of Standard Deviations Above or Below Mean for the Full Time Horizon

The two peaks in the Dyadic Liberal Index can be used to further draw distinctions between Liberalism and the CoI Index (described below). The Cold War distribution for the Dyadic Liberal Index shows peaks that are much more pronounced than the histogram shown above (much greater above and below the mean relative to at the mean). The peak with lower absolute values is populated dyads in the Soviet Bloc (very low Liberal scores, but very high CoI Index scores). Countries in the higher peak were Western Democracies with equally high CoI Index scores and very Liberal. See the cross sectional graph below plotting Liberalism and CoI Index scores for further explanation of the difference between Liberal and CoI Indices.

The line-graph below shows dyadic Liberalism scores for selected countries across time. The scale on the left is the number of standard deviations above or below the mean for the entire sample size of data[42]. The data in this graph indicate that, in the mid-1960's the US and China were approximately as liberal as the average of all dyads over this entire time period. This is largely due to the Liberalism of the US and not the Liberalism of China[43]. This dyad grows relatively steadily across time, eventually becoming fairly liberal (more liberal than the world average, as will be demonstrated below). The bottom dyad in the line-graph below is North Korea and Burma, two of the most illiberal states in the international system.

[42] After each of the three sub-indices were created on 0-1 scales they were averaged into a single index. The mean and standard deviation for that index (for the years 1960-2001) for all available dyads were taken. Each individual dyadic index score was then subtracted from the mean and divided by the standard deviation.

[43] A shortcoming of this approach is that it does not treat relationships that are mixed regime types as effectively as it could. For example, dyads that are mixed (like the US and China in 1965 with the former very liberal and the later very illiberal) could be coded as having very low dyadic levels of Liberalism. It is an empirical question as to whether these mixed dyads should be treated differently and in subsequent work that will be explored.

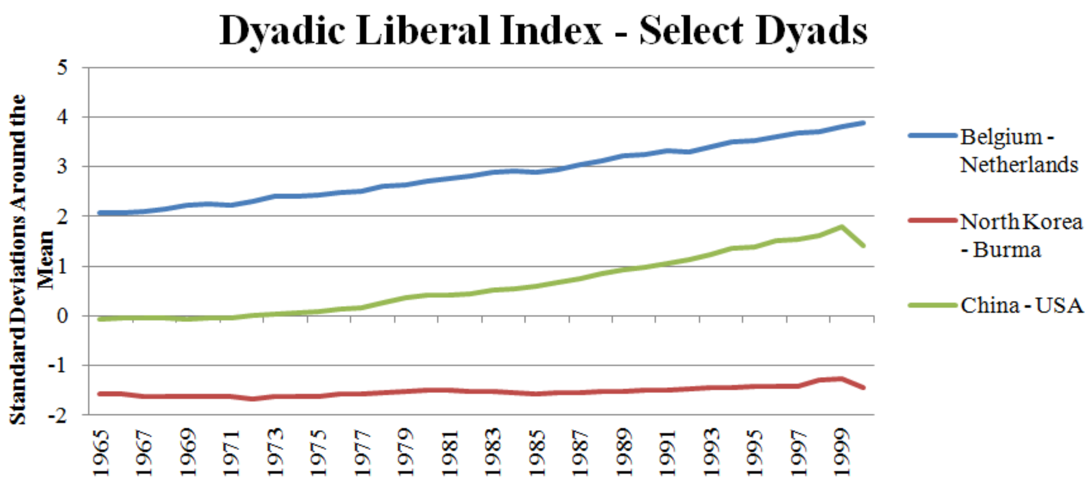

Figure 39: Liberal Index for Selected Dyads. Y-Axis is Number of Standard Deviations above or below the Mean for the entire distribution of data from 1965-2001

Taking the global average of all standardized dyads across time tells a familiar story about increasing levels of trade, democracy and membership in international organizations. Measuring "up" from standardized dyads, the world was fairly illiberal from the mid 1960s to the mid 1970s. This was caused by a relative decline in global average democracy for that period coupled with moderate growth in trade and strong growth in embeddedness in international political organizations. However, after these liberal doldrums, global dyadic average Liberalism grew rapidly. First, this was driven by increases in trade and embeddedness in international political systems and then the rapid democratization that occurred at the end of the Cold War. The line-graph below tells this story.

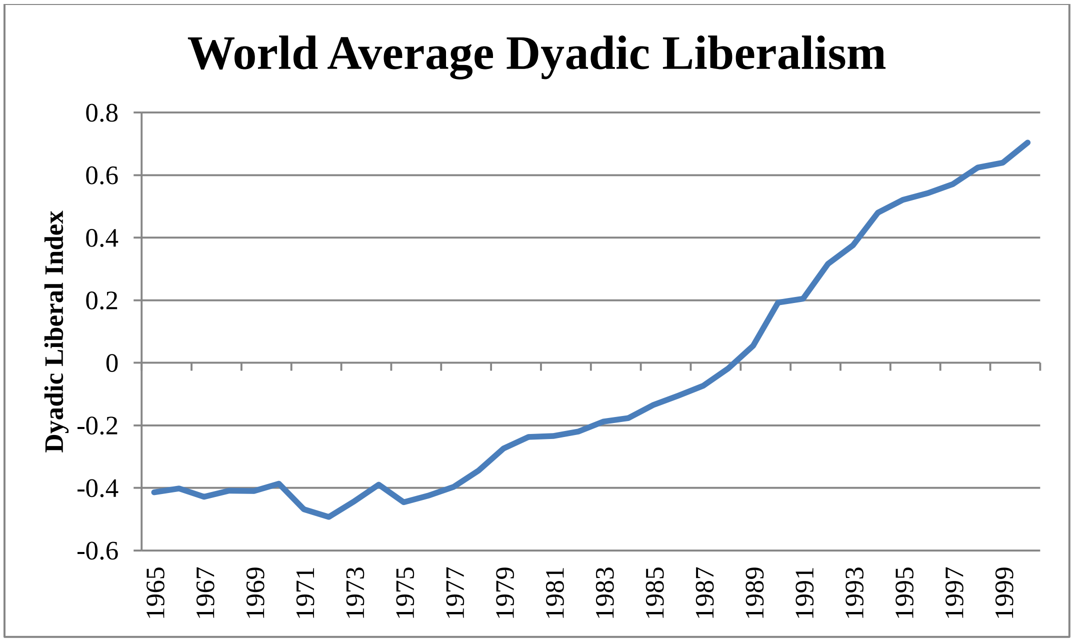

Figure 40: Liberal Index for World Average. Y-Axis is Number of Standard Deviations above or below the Mean for the entire distribution of data from 1965-2001

The line graph below measures the average Dyadic Liberal Index score for World Bank income groups. This measure was taken by looking at the average Dyadic Liberal Index score for all dyads that share membership in the groups below. First, the distribution across time correlates to levels of income, with High Income countries having higher average Dyadic Liberal Index scores than Upper Middle Income countries, followed by Lower Middle Income countries and Low Income countries. Next, levels of Average Dyadic Liberal Index scores increase across time for all income groups. The steadiest increase occurs in both High and Upper-Middle Income groupings. Low and Low-Middle Income groupings stagnate for much of the time horizon, growing only through the 80s and 90s. Interestingly, in absolute terms, neither Low Income or Low-Middle Income groupings achieve absolute average liberal levels achieved by the High Income World Bank group at any point in this distribution.

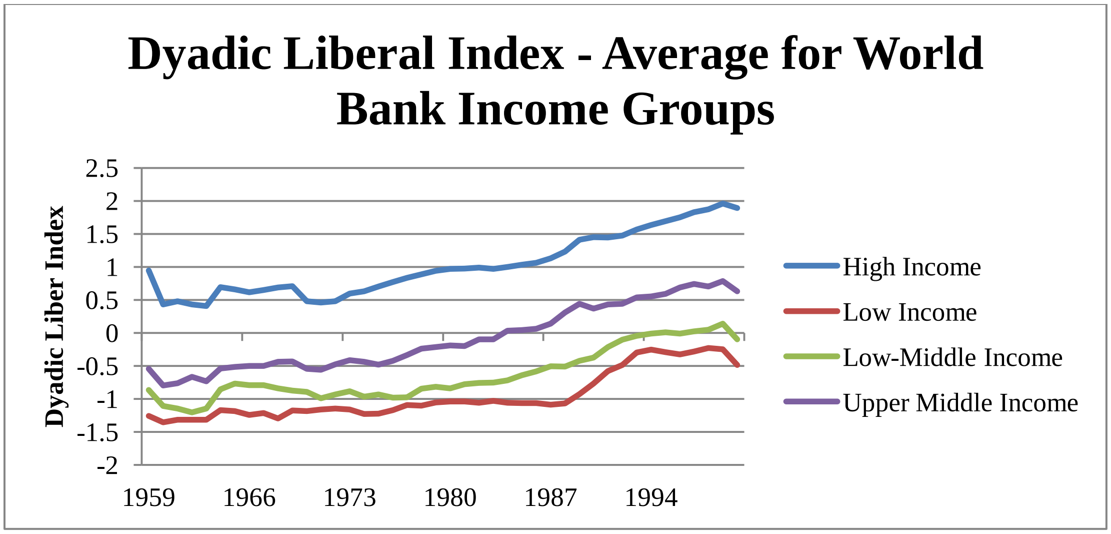

Figure 41: Dyadic Liberal Index: World Bank Income Group Average Scores[44]

Selected dyads that have a history of rivalry display a similar explanatory problem to the Dyadic Realist Index. In the line-graph below are three dyads: India and Pakistan, North and South Korea, and Iran and Iraq. Each dyad below experienced protracted military engagements across these time periods that result in fatalities (as measured by the Militarized Interstate Dispute dataset) (Ghosn, Palmer, and Bremer 2004).

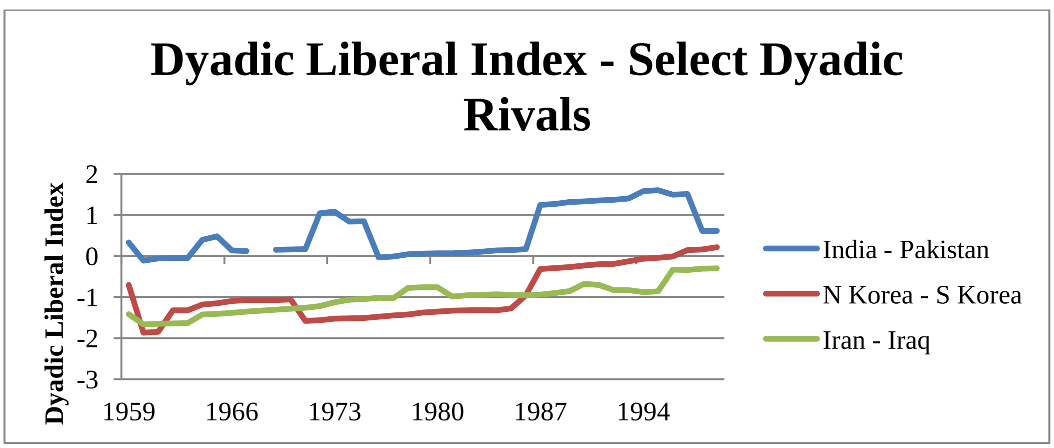

Figure 42: Dyadic Liberal Index Select Dyads

[44] Groupings fixed across time with 2011 membership

Though their levels of bilateral conflict were similar, their levels of bilateral Liberalism were not. The next section of this chapter will present the construction of the third IR index deployed in this analysis. The final section will create a statistical model that will evaluate the relative explanatory power of each index in isolation and as an aggregate measure on the historic occurrence of international conflict.

Building the Cultures of Interaction Index

The Cultures of Interaction Index (CoI Index) is an attempt to get at something that is neither fully Realist nor fully Liberal. It draws on both Liberal and Realist standard operationalization approaches, using the dyadic focus that Realism uses frequently and Liberalism uses occasionally, as well as many variables frequently used by Liberalism. However, the output is not exactly Liberal and is certainly not Realist: many fairly illiberal dyads can have very high CoI Index scores, like former Soviet Bloc countries and many countries in the Middle East.

This index attempts to gauge the character of bilateral state interaction on a scale ranging from friendly to antagonistic. It rests on the assumption that, if two states are actively aligning foreign policy, treaty signing, international organization membership and trade flows, that they are creating a culture of interaction that promotes cooperation. It takes Wendt's Cultures of Anarchy (which is conceptualized at the international system level) and tries to gets at a similarly socially constructed behavior between states at the dyadic level. In this sense the CoI Index can be said to range from a Kantian culture of interaction, through a Lockean culture and towards a Hobbesian culture (from friendly towards antagonistic). I assume that this kind of behavior can be identified through extant indices.

I argued in Chapter 4 that standard operationalization of both Liberalism and Realism are vulnerable to three types of criticism: excessive parsimony, poor treatment of complex interdependence and a lack of emphasis on cultures/intersubjective meaning making. The CoI Index does not actually solve any of these criticisms in an absolute sense. Instead it attempts to "pull threads" from these criticisms of IR and build a dyadic measure that is more nuanced than either the Liberal or Realist Indices have been historically operationalized.

One component of the increased nuance of the CoI Index relative to either Liberalism or Realism is that it *begins* from the dyadic level. While some Liberal indices have used dyadic trade as a sub-component but not in each sub-measure, the CoI Index starts by measuring the treaties, organizations and trade relationships from the ground up. Both Realist and Liberal indices started with country-year indices which are not dyad specific. Beginning with dyads as the level and unit of analysis changes the focus of the index. Here, countries can have great bilateral relationships while having very poor bilateral levels of Liberalism and/or Realism. This complex interdependence will have an impact on the intersubjective meaning-making at the dyadic level, in other words, the culture. It considers complex interdependencies: standard Liberal measures consider a country's affinity with global norms, not country-specific norms. The CoI Index measures a series of dyadic interdependencies that are contextual. It also is geared towards thinking about culture: the variables chosen for the CoI are all operationalized on a dyadic basis and are all oriented towards measuring complex interdependencies between a pair of states.

I create the CoI Index by manipulating five sub-indices. These are outlined in the table below. For all of the data manipulation the countries included are the 183 that are modeled within the International Futures system.

Table 4: Defining the CoI Index

	Original Data	**Manipulation Description**
International Organization Membership	Correlates of War	Measured Total Number of Shared IGOs Between Dyad Year
UN Treaty Embeddedness	United Nations Treaty Database	Measured Total Number of Shared Treaty Signatories Between Dyad Year Weighing Ratified Treaties More
Diplomatic Connection	Correlates of War	Binary Presence of Diplomatic Connection
Alliances	Correlates of War	Presence of Alliance Privileging Size of Overall Alliance
Trade	Correlates of War	Actual Trade Minus Expected (Gravity Model)

The logic of the calculation of the CoI Index for two countries is shown in the equation below. Each variable with the sub-text "threshold" is the highest level that any of the dyadic measures reach in the base-year. For the historic data, that is 2001.

$$Cultures\ of\ Interaction_{Country\ A\ B} = ((Shared\ IGO\ Membership_{Country\ A\ B} / Shared\ IGO\ Membership_{Threshold}) + ((Shared\ Treaty\ Ratification\ or\ Signed_{Country\ A\ B}) / Shared\ Treaty\ Ratification\ or\ Signed_{Threshold}) + (Shared\ Embassy_{Country\ A\ B} / Shared\ Embassy_{Threshold}) + ((Actual\ Trade_{Country\ A\ B} - Expected\ Trade_{Country\ A\ B}) Actual\ Minus\ Expected\ Trade_{Threshold}) + (Diplomatic\ Exchange_{Country\ A\ B} / Diplomatic\ Exchange_{Threshold})) / Cultures\ of\ Interaction_{Threshold}$$

The first sub-index of the CoI Index is taken from the Correlates of War Intergovernmental Organization Database (Correlates of War Project 2008; Pevehouse, Nordstrom, and Warnke 2004). This data series measures whether 213 states are members of 495 different international organizations (again, the full number of countries is parsed down to the IFs list of 183). The data stretches as far back as 1815 (Bavaria was a member of the *Central Commission for the Navigation of the Rhine* in that year, for example) through 1965 in five year intervals. From 1965 forward, the data is annual until 2000.

We expect states interests to align when they are members of similar international governmental organization networks. This is not to say that shared IGO membership indicates that two states have a fully converged set of interests, just that this is one measure of state initiated activity that is oriented towards an alignment of interests in an international space.

This data was then taken on a bilateral basis. This approach explores these relationships in great granularity by country-pair for each year. I am interested in measuring the number of IGOs that every two pairs of countries in the world share membership in for every year. For example, pairs of countries in Western and Northern Europe tend to be members of very many of the same international organizations. I assume that their international diplomatic policy choices are more aligned than countries that have relatively fewer diplomatic connections of this type. The line-graph below averages the standardized shared number of IGO memberships for each dyad pair within that region.

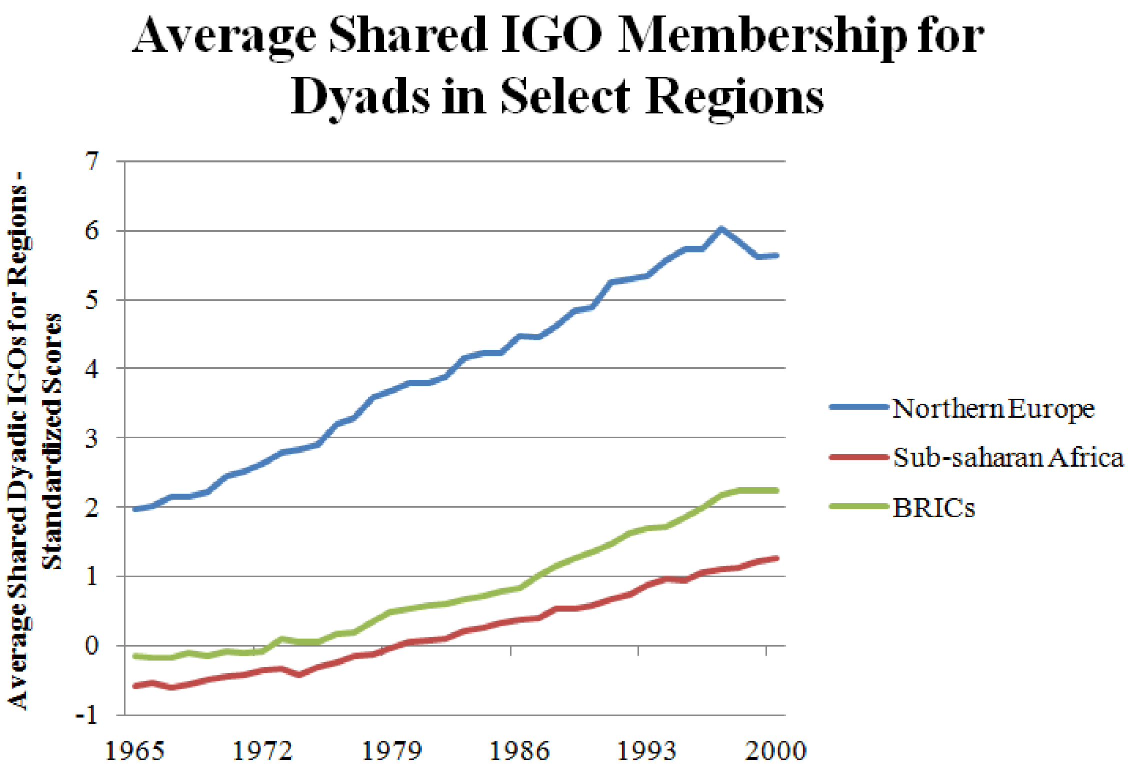

Figure 43: Culture of Interaction Index Selected Regions

The second sub-index used to create the CoI Index was taken from the United Nations Multilateral Treaties Database (United Nations 2011). This database records all multilateral treaties that are deposited with the Secretary General of the United Nations. The database identifies the treaty name, countries who have committed themselves to the treaty and the degree to which they are committed demarcated by those who signed the treaties and those who ratified them[45].

The individual UN treaty scores for countries were then added up. Scores were weighted differently for treaty signatory as compared to ratification. Ratification was

[45] Previous to this project this data did not exist in an easily manipulatable form (ie., in list form, for example). The data is freely available to those who query the author.

deemed to be twice as important as signing a treaty[46]. The line graph below identifies the average global distribution for countries signing/ratifying multilateral treaties kept with the United Nations Secretary General. The pattern is clearly up across time, with an even greater increase in the rate of growth at the end of the Cold War. Here, many new Eastern European countries deeply embedded themselves in international treaties.

Again, this data was taken at the level of dyadic relationships. The figure below identifies select countries and their bilateral UN treaty alignment across time. Finland and the Netherlands have a historically strong bilateral alignment of UN treaty signings (they have the highest 2010 values, and are consistently high across the total time horizon).

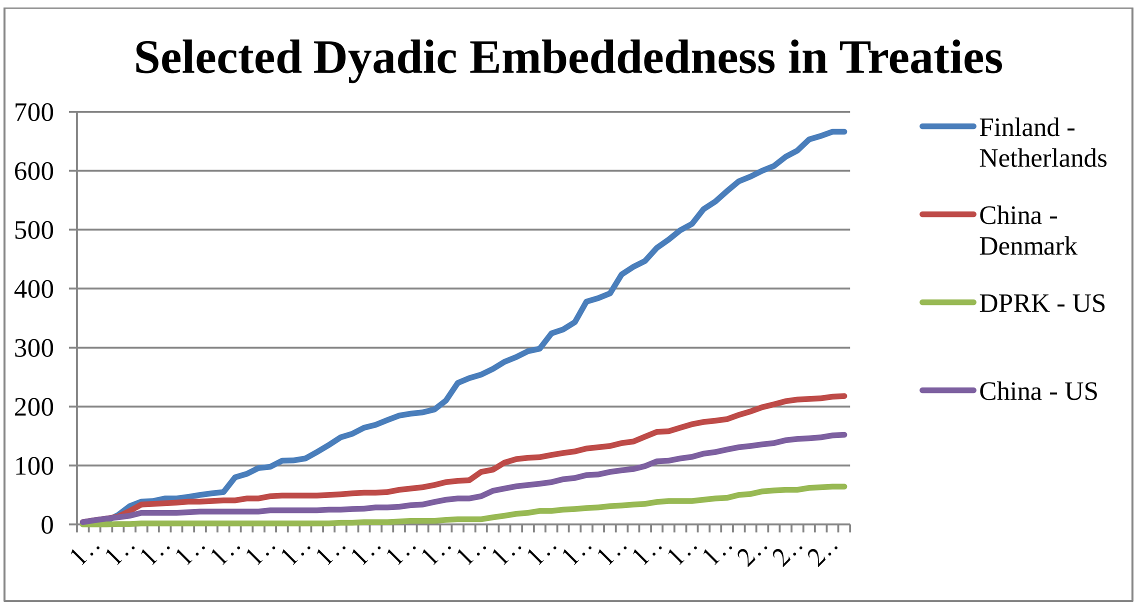

Figure 44: Selected Dyadic Embeddedness in Treaties (Author Compilation)

The third sub-index used to create the CoI Index is the level of Diplomatic Connection between pairs of countries across time. This series is also produced by the

[46] It is important to note that this is an imperfect weighting. If countries are democratic and the ratification of international treaties has to pass through a system of congress or parliament then it is important to note that it is much more difficult to ratify than sign treaties. This general constraint does not exist for authoritarian countries who can generally more easily ratify treaties.

Correlates of War project (Bayer 2006). This series measures—at a dyadic level—the diplomatic interaction of all states in the international system across levels of commitment. The data is available from 1817 to 2005, generally in intervals of three or five years.

Diplomatic connection between countries indicates an interest in formalizing relations. Typically, the most powerful states in the international system have both diplomatic connections abroad and many connections at home as well. For example, in 2001 164 countries had embassies in the US and the US had embassies in 162 countries. In the same year, 125 countries had embassies in China while China had embassies in 152 countries. In contrast, 12 countries established embassies in Chad, and Chad established only 18 abroad (Europa Publications Limited 2001).

This variable performs tends to reflect both wealth (identified in the paragraph above) and political machinations. The line graph below identifies relationships between selected countries. The blue line represents India and Pakistan, which have experienced tumultuous relations across time, with the Indo-Pakistani war of 1971 clearly souring relations. The green line—representing Argentina and the UK—also identifies trends in the relations between states. Up to 1970 the relationship was not fully reciprocal until the 1970s; a product of income and distance. After the relationship increased to full bilateral embassies, the Falklands War caused a reduction in diplomatic exchange. The third line represents the exchange between the US and Vietnam. Before the early 1980s there was no bilateral embassies between the countries. The establishment of embassies was one important step on the path to smoothing bilateral relations more broadly[47].

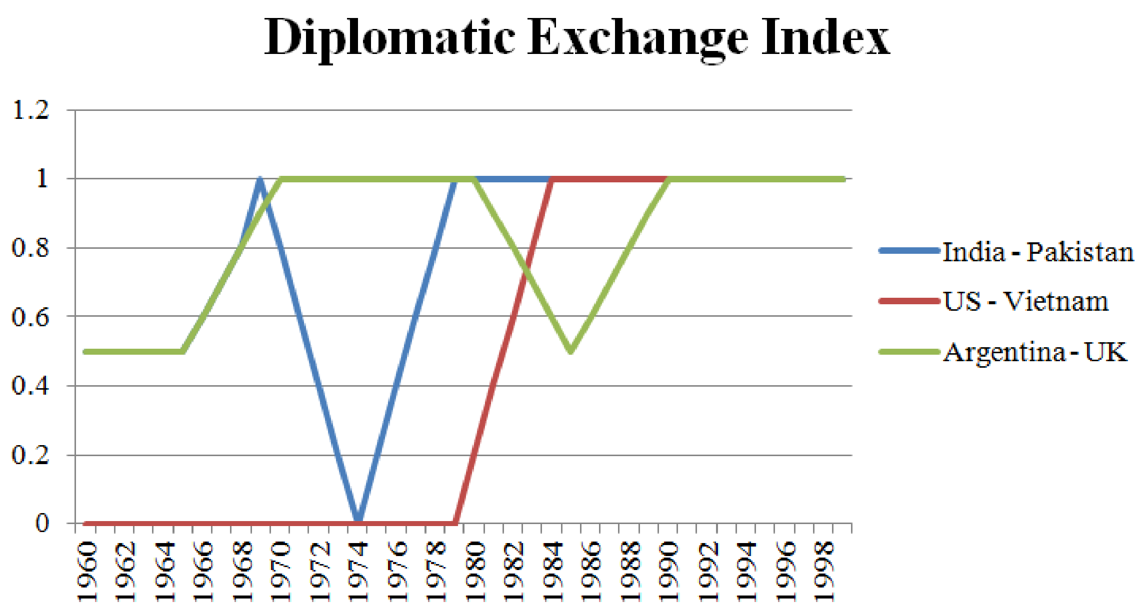

Figure 45: Diplomatic Exchange Index - Correlates of War (Bayer 2006)

I take this value and create an index from 0-1, with values of 1 indicating full, bilateral embassy exchanges and values of 0 representing no exchange.

The fourth sub-index that is used to create the CoI Index is diplomatic alliances. This measure is equally weighted between the presence of a bilateral alliance and the broader strength of that alliance. The data is, again, taken from the Correlates of War project (Gibler and Sarkees 2004). This measure is relatively straight-forward conceptually and as an applied sub-index to the CoI Index. Conceptually, if countries are allies then they are less likely to go to war with one another.

The final sub-index to the CoI Index is a measure of actual trade versus expected trade on a bilateral basis. This measure is a proxy for the quality of state relationships

[47] The measure before 1975 for Vietnam was only for North Vietnam and the US. Next, the values for this data are interpolated between five year series for presentation and data smoothness.

across time that has received some attention in the literature on conflict (Keshk, Pollins, and Reuveny 2004), but not in the way that it is used in this project. This measure identifies which partners countries are trading with more than their level of GDP and their proximity would indicate. This is not the same measure as was used in the Liberal Index. Countries with very high levels of Liberalism can have low levels of expected-to-actual trade values.

For this project a gravity model was constructed where the output variable was bilateral measures of trade and the independent variables were overall levels of country income, physical distance and the year. The gravity model has been widely deployed for econometric analysis across time (Anderson 1979; Mátyás 1998; Mátyás 1997). The construction of the model for this project used data on geodesic distance from the *Centre d'Etudes Prospectives et d'Informations Internationales*, a leading French data source for issues on trade and international economics. The distance data used is called *distw*, which calculates distance between countries weighted for the proximity of people, not territory. In other words, if two countries are touching territorially but have actual population centers at great distances (think about the US and Russia, for example) this measure will characterize the dyad as being more distant than their territorial proximity would suggest (Mayer and Zignago 2006). For data on national income, Gross Domestic Product at Market Exchange was used from the International Futures system, which itself draws on a variety of sources (Hughes 2007). Trade flow information was again taken from the Correlates of War project, which measures bilateral trade flows across time (Barbieri, Keshk, and Pollins 2009).

The actual regression was created using logs of bilateral GDP and trade flows to represent diminishing marginal returns to increases in flow size. The actual model output (with three independent variables) produced an r-squared of 0.65 with significant t ratios and p values for everything (at the level of 99%). See Appendix 3 for full model results. The equation used is the following:

*Expected Bilateral Trade = -39.43 + 1.69 + (Sum of Log GDP for Two Countries) + 0.000385 * (Inverted Weighted Distance) + (0.0129 * Year)*

Using this formula I created an expected trade value for all dyads across time. I compared this with the actual value of bilateral trade between countries, subtracting the later from the former. Some examples of the performance of the gravity model are shown in the three line-graphs below.

The first example is from the bilateral relationship between the US and Vietnam over time, beginning in the first year of available data, 1976. This shows an initially very low level of actual trade to expected, a reflection of the history of conflict and distrust between the countries. The relationship between these countries improves dramatically throughout the late 1980s and into the 1990s, eventually indicating that Vietnam and the US are trading at higher levels than expected[48].

[48] Values interpolated for 1982,1983, 1985, 1987, 1988, 1989, 1990, 1991, 1992, 1993

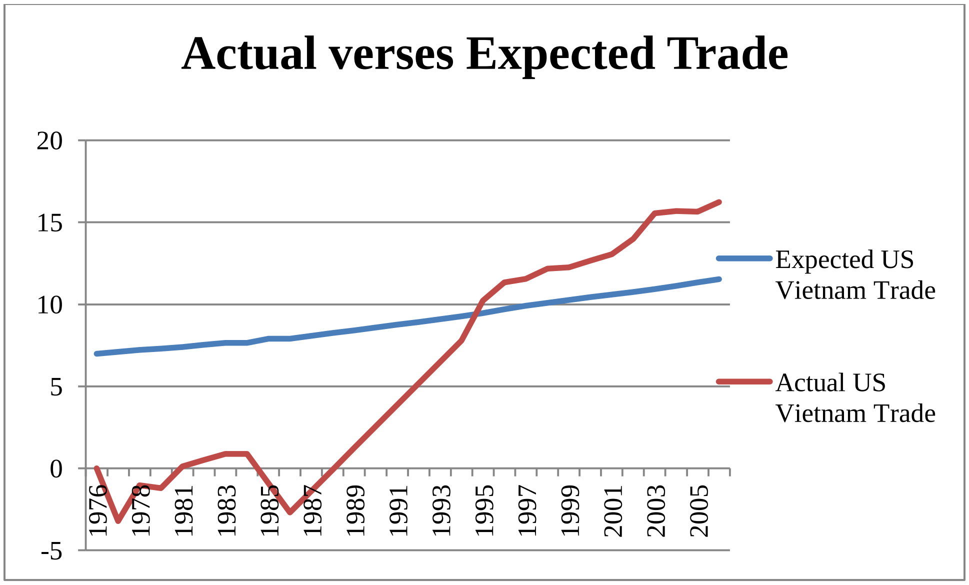

Figure 46: Actual Verses Expected Bilateral Trade - US and Vietnam

The second example comes from the trade relationship between Argentina and the United Kingdom. Early data shows that the pair of countries experienced fairly strong trade relationships, higher than would be expected based solely on their physical proximity and the size of their economy. The Falklands War brings about a dramatic reduction in the size of trade relative to expected values. This relative souring of the relationship between the two countries extends throughout the early 1990s and eventually improves and reaches expected trade values again.

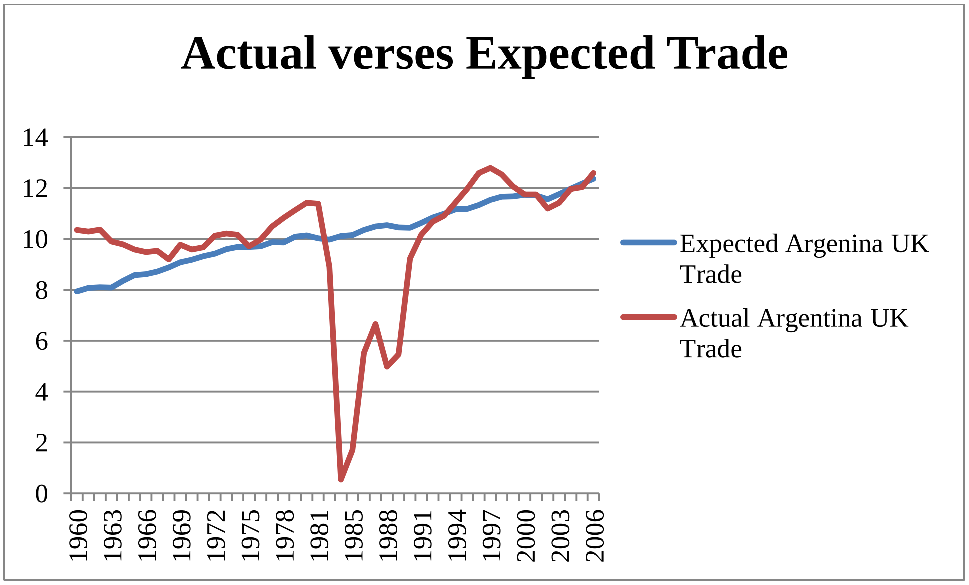

Figure 47: Actual Verses Expected Bilateral Trade - Argentina and UK

The final example of the performance of this index is between two countries that have had historically strong relationships stemming from colonialism. The relative size of the economies of the Democratic Republic of the Congo and Belgium and their physical proximity would indicate that their levels of bilateral trade would be relatively quite low, but their political proximity and the strong economic ties that extended post colonialism show much higher actual trade to expected trade.

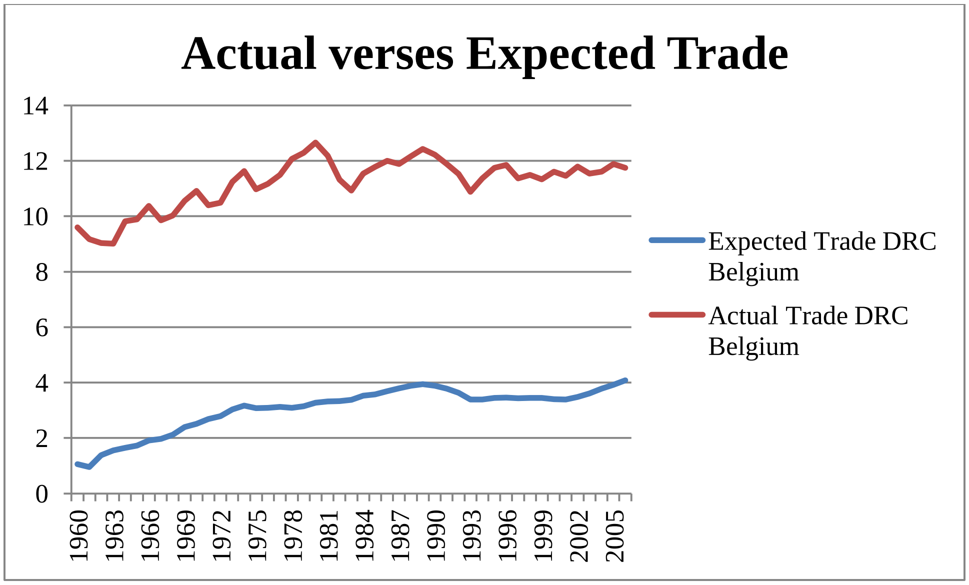

Figure 48: Actual Verses Expected Bilateral Trade - DRC and Belgium

The scores of actual trade to relative trade are subtracted and turned into a 0-1 index.

The five sub-indices are standardized to identify the relative distance of each country around the mean distribution of the sub-index. In other words, the standardization process allows for the internal comparison of sub-indices across sub-indices, as well as providing a score that is not bound by upper and lower limits. The standardized sub-indices were then averaged into a Cultures of Interaction standardized output.

The number of observations for the CoI Index from 1960 to 200 is 457,960. The distribution of the standardized score (see the vertical histogram, below) show a handful of relationships that fall more than 2 standard deviations above the mean (8,058 observations fall more than 2 standard deviations above the mean, or 1.8% of all dyad years).

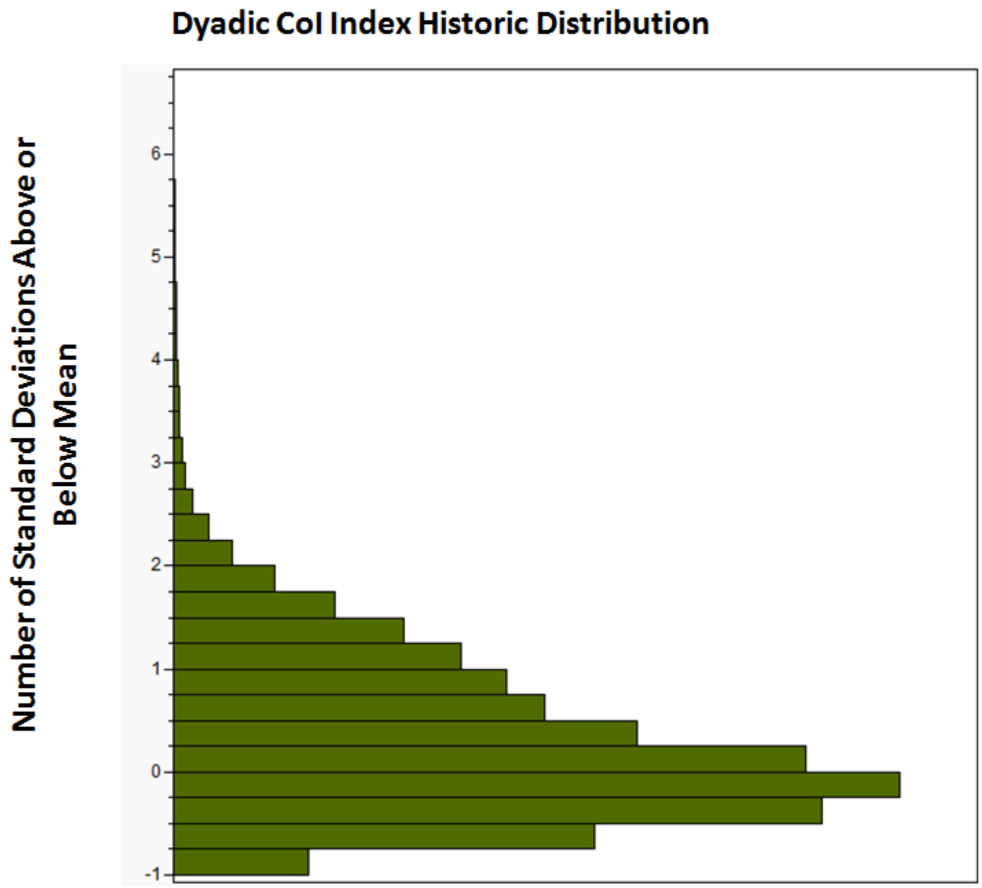

Figure 49: Histogram Measuring Distribution of Dyadic Cultures of Interaction Index. Y Axis is number of Standard Deviations Above or Below Mean

Evaluation of Indices

I have argued that an integrated analysis can be conceptually parsimonious (but not excessively) while including impacts from a range of theoretical and applied systems. I have argued in Chapter 3 that IR theory might benefit from an approach that understands Realism and Liberalism to be mutually beneficial theoretical tools that should be used in conjunction to evaluate state behavior in the international system. I have also made the claim that criticism of standard-bearer approaches to IR point to a third type of approach that embraces nuance, complex interdependence and culture. I introduced the actual measure of that above.

In this section I am interested in evaluating how these IR indices behave when modeled with the historic occurrence of international conflict. I test whether the three approaches to IR that I have constructed above have more explanatory power in isolation, or as an aggregate index. If I can show that the three operationalized theories have utility as an aggregate index then I can justify using a combined quantitative measure of Realist, Liberal and the CoI Index to tell stories about international relations historically as well as forecast this measure to 2050. I choose conflict as my independent variable because it represents the ultimate deterioration of dyadic relations. Two states can experience a deterioration of relations that falls short of conflict, but conflict represents one extreme stage of state behavior that we can measure.

One claim of this project is that there is a distinction between the CoI Index and the Liberal Index score. They both contain some of the same variables, so we would expect correlation. In fact, the CoI Index builds upon Liberalism and should be seen as a complimentary measure. Conceptually and operationally, however, the measures are distinct. As was argued before, the Liberal Index operationalized dyadically represented the level of interdependence of the pair of states at the *global* level.[49] The CoI, instead, is a dyad specific measure. It measures dyadic policy alignment. Two countries can score very high on the Dyadic Liberal Index and very low on the CoI Index.

[49] I operationalized Liberalism globally for two main reasons: it is normally treated as such, and I needed a measure that I could forecast over a long time horizon within IFs and dyadic trade is not treated in IFs.

The cross-sectional plot below shows the relationship between the CoI Index and the Liberalism Index for all dyad years. Each dyad-year is represented by a black dot. The shaded red areas indicate the largest concentration of dyad-years within the distribution. First, it is clear that there is some relationship, but that it is not a one-to-one interaction between the two measures. If you fit a line to this distribution, it produces an r-squared measure of 0.33, indicating that 33 percent of the variation in the y axis around the regression line is being explained by the x axis.

Many dyad-years fall either above or below the regression line. Many Soviet states were very il-Liberal but also had fairly high CoI scores, a pattern shared by authoritarian regimes from South America in the 1970s. Dyad-years that more recently experienced high levels of Culture of Interaction but low levels of Liberalism were North African. There are examples of countries at the other end of the spectrum that experience high levels of dyadic Liberalism but low CoI Index scores. These dyad-years tend to be less powerful states who are at a distance (Luxemburg and Mongolia in 1999, for example, dyad years where one member is newly democratic (Estonia and Norway in 1991), dyad-years where one state is newly independent (Denmark and The Gambia in 1965) or a combination of all three (New Zealand and Mauritius in 1968).

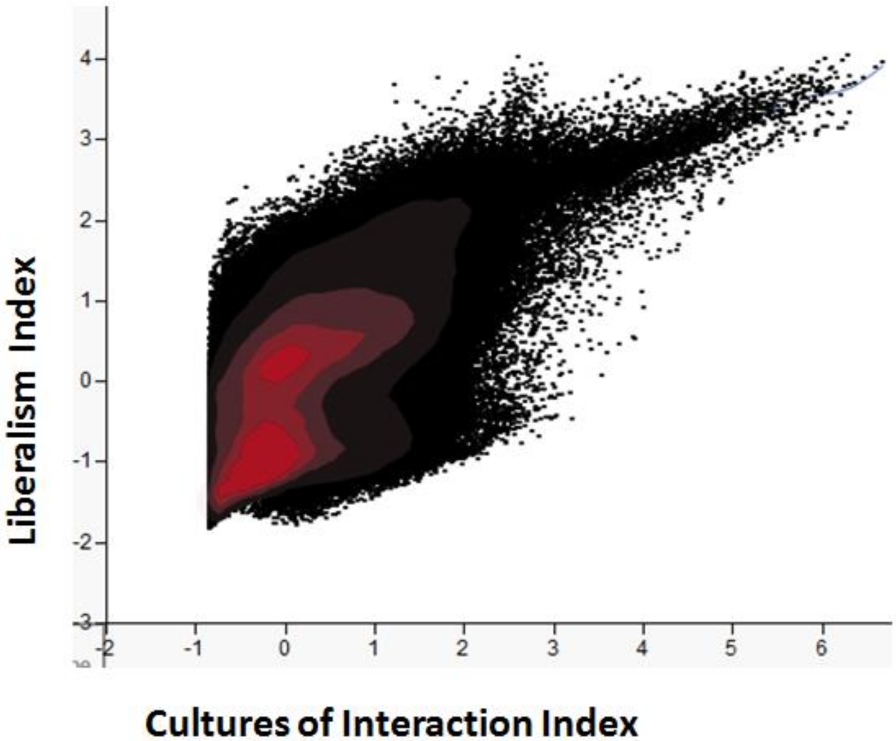

Figure 50: Cross-Sectional Plot of Cultures of Interaction Index and Liberal Index Dyadic Score Results - Red Indicates High Density

The cross-sectional plot below identifies the relationship between the CoI Index and the Realist Index. It demonstrates a weak relationship, in general (with an r-square of 0.10 with a linear fit). Dyad years at the bottom right—with very high CoI Index scores, but much Realist pressure—are mainly Western European medium to large states. These include the UK and France, Norway and Denmark and France and Italy (all for various years). Dyad years at the bottom left are mainly from earlier in the time horizon and include relatively materially poor states with poor relations. These include Oman and Somalia, Mali and Burkina Faso and Chad and Niger. At the top-right of this cross sectional plot—countries with very high CoI Index scores yet very little realist pressure. These dyad years include states mainly in Western Europe that are either territorially not contiguous, or that have large discrepancies in relative power, such as Luxemburg and all other Western European states, for example. At the top-left of this cross sectional plot lie the overwhelming majority of dyad years in our distribution. Again, the density of dyads in the distribution is highlighted by the red shading. Most dyad years experience no realist pressure (identified above in the distribution analysis of the historic index) and thus clump at the top of this cross-sectional plot.

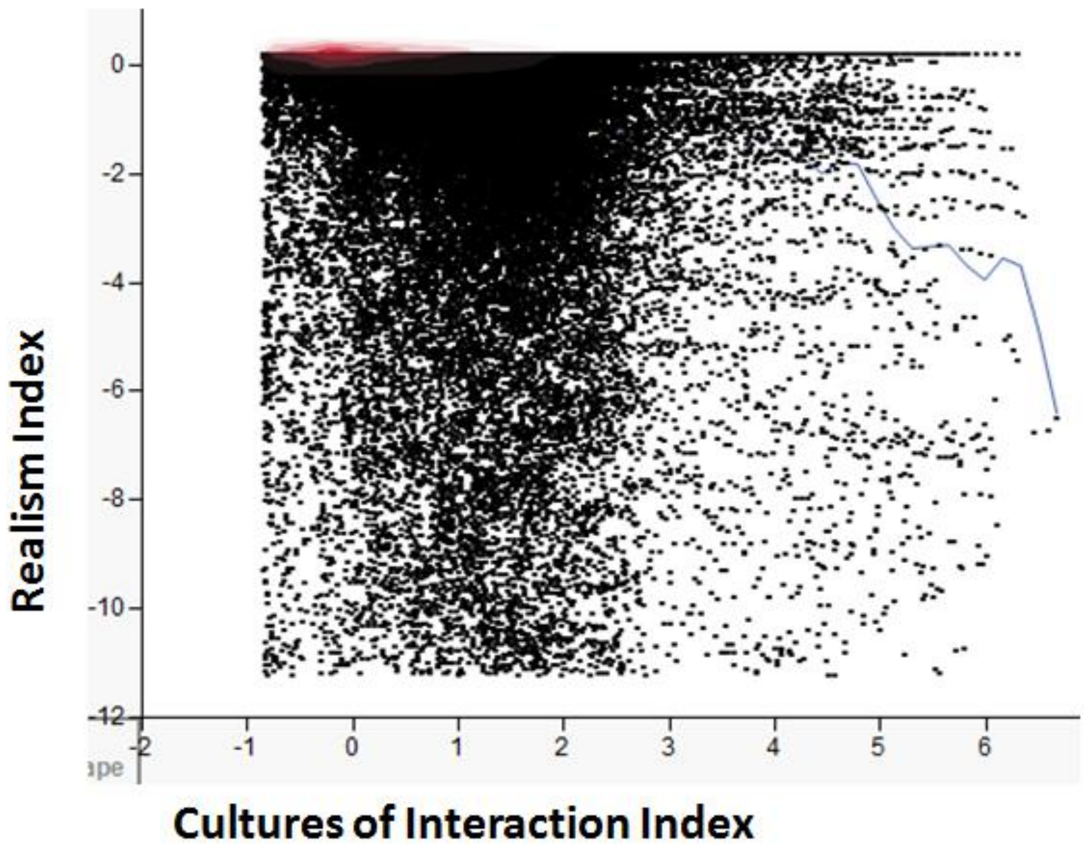

Figure 51: Cross- Sectional Plot of Cultures of Interaction Index and Realist Index Dyadic Results - Red Indicates Higher Density

The relationship between the Realist Index and the Liberal Index is even weaker than the relationship between the CoI Index and the Realist Index. A linear regression between the two indices shows a linear curve to with an r-square of 0.01. While the strength of relationship is much worse, an exploration of the particular dyad-years in each of the four quadrants shows similar patterns to the relationship between the CoI Index and the Realist Index, discussed above. This should not be surprising, as the overall distribution of the results is dominated by the very large number of dyad years that are scored as having no pressure by not being politically relevant.

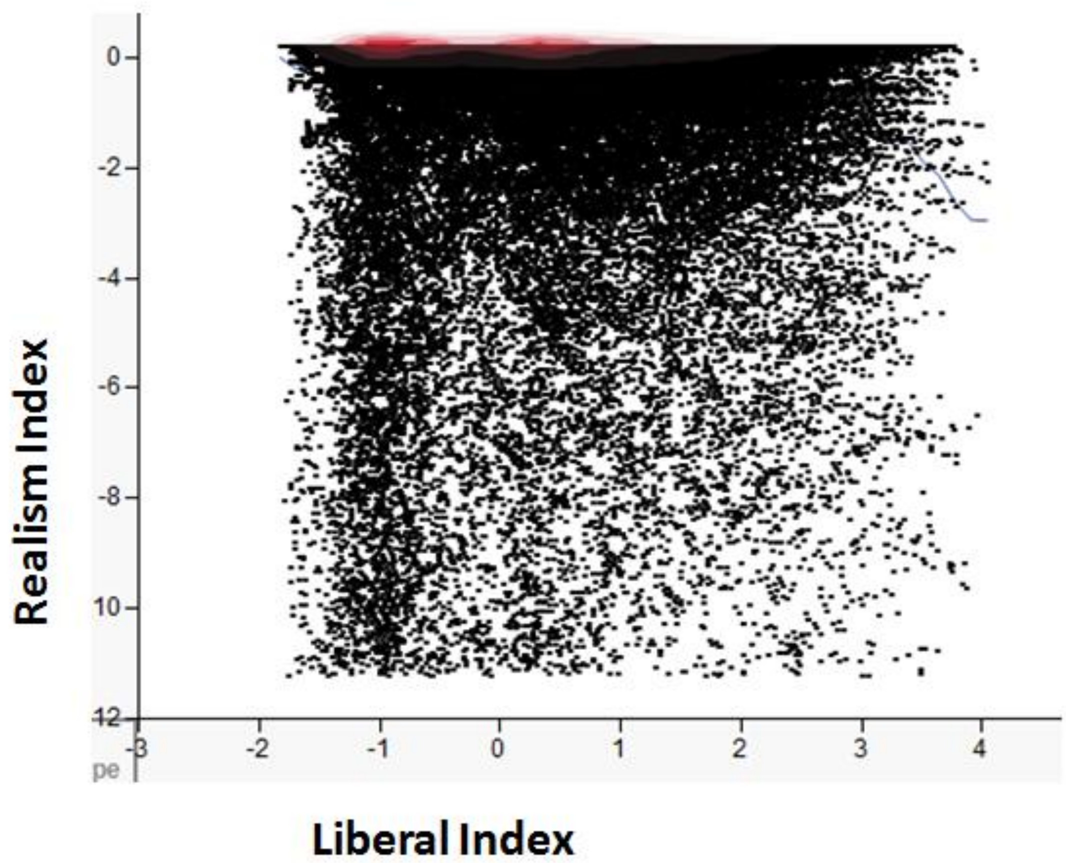

Figure 52: Cross Sectional Plot of Realist and Liberal Index Dyadic Results - Red Indicates Higher Density

There are many ways that these three indices could be brought together into one synthetic representation of the threat of dyadic interactions in the international system: one variable could drive weights for other variables algorithmically, for example. For the purposes of this project, it was determined that the simplest synthesis of these three indices would be the most straightforward for analysis. For the synthetic index, the CoI, Realist and Liberal indices were aggregated. I also compare the Realist and Liberal Indices in an aggregated index with the historic occurrence of conflict. This is to build a case for my forecast approach, discussed in the next chapter, where the CoI cannot be endogenized within IFs.

The purpose of the analysis that follows is not to create a model of the occurrence of international conflict with the most robust statistical fit. This kind of work has been done by others, starting with Wright (1964) and extending through the Correlates of War project (Singer 1972; Singer and Small 1994; Wallace and Singer 1970). More recently Bennett and Stam (2004) have produced a comprehensive statistical analysis of the relationship between the occurrence of war and driver variables mentioned earlier in this project.

The purpose of this dissertation is not to replicate this work. The occurrence of conflict is a difficult thing to measure statistically for a variety of problems (King and Zeng 2001). This is true of both domestic and international conflict. In the field of domestic conflict, this has produced two kinds of measures, one that is probabilistic and the other that is an index. The probabilistic measure captures the best statistical relationship with the historic occurrence of conflict (just like the authors did in the previous paragraph). This is useful, but insufficient for a full quantitative analysis of conflict.

Conflict happens for a wide variety of reasons and probabilistic measures provide much emphasis to historic drivers. An example may prove useful. One recent attempt to predict the occurrence of domestic conflict using a probabilistic measure was produced by Hewitt, Wilkenfeld and Gurr (2012) and used measures that have evolved from work done on the State Fragility Task Force (Esty et al. 2007; Goldstone et al. 2010). The results of this study widely miss the mark when it comes to the actual occurrence of the Arab Spring. The Peace and Conflict 2012 report measures the "risk of future instability between 2010 and 2012" to be "low" for the following countries: Bahrain, Egypt, Lybia, Syria and Tunisia. However, far from having a low risk of future instability, each of these countries experienced large-scale domestic conflict in this time period.

This is not to say that probabilistic measures are not useful for anlaysis. On the contrary, they are an important step in furthering our understanding of the drivers of conflict, be they domestic or international. However, they are not a panacea, and index measures—conceptually sound and statistically relevant—can provide additional insight into how likely conflict is moving across time.

One central hypothesis of this project is that a synthesized model of international relations will have a more meaningful relationship with the actual occurrence of conflict than any of the three key theories of international relations explored. To test this I have to explore my five international relations models (Realism, Liberalism, CoI, Realism + Liberalism + CoI, Realism + Liberalism) with the historic occurrence of conflict. This section of the dissertation performs that evaluation. It concludes that, yes, the integrated model of international relations theories performs better than any of the models in isolation.

To test this I take two measures of international conflict and subject my five indices to a logistic regression analysis. I measure the occurrence of conflict in two related datasets. The first is the Militarized Interstate Dispute (MID) dataset produced by the Correlates of War. This dataset measures whenever a militarized conflict between two states occurred and whether a fatality occurred. MIDs can be of a very low threshold, and can involve seeming “accidents” and other miscommunications between pairs of states in the international system. MIDs were defined in Chapter 1 and include conflicts, “…that range in intensity from threats to use force to actual combat short of war” (Jones, Bremer, and Singer 1996, 163). The other measure used for this analysis is the Correlates of War account of actual interstate war. The threshold of this conflict is much higher (1,000 battle field deaths), and involves the deployment of actual troops, full military operations and the declaration of war (Sarkees and Wayman 2010).

Logistic regressions are useful for measuring nominal dependent variable data with a probability that it will occur based on an independent variable value. These methods are suitable for analyzing variables with characteristics similar to the occurrence of historic conflict (as it can be represented as a binary). The distribution of the independent and dependent variables in my sample make many statistical samples problematic. See the figure below for a visual representation of the problem: the vast majority (over 99.5%) of observations have a dependent variable with a value of “0” (representing no conflict). The incredibly small number of independent variables can skew my results and vastly under-estimate the occurrence the prediction of a “1” (King and Zeng 2001).

This is not a problem for my analysis because the end of this hypothesis testing is not the creation of a model with the best statistical fit to the historic occurrence of conflict. As argued in Chapter 2, this has been done by others (Bennett and Stam 2004).

Instead, I am interested in comparing the relative strength of the different indices related to the historic occurrence of conflict.

Logistic regressions model independent variables against a binary dependent variable. This is done by fitting the data with a sigmoid-curve (more commonly referred to as an “s-curve”). It is superior to linear regressions when dealing with binary output variables that are not normally distributed (though this is still problematic, see King and Zeng 2000 as noted above). The logistic regression equation is demonstrated below.

$$Natural\ Log\ \left(\frac{Y}{1-Y}\right) = A + B * X$$

The cross sectional plot below shows the distribution of the aggregate measure of the character of bilateral relations in the international system along the x axis and the occurrence or non-occurrence of a fatal conflict dyad year along the y axis. A logistic regression was used to test the goodness of fit of the aggregate index measure and compare it to the three IR indices standing in isolation.

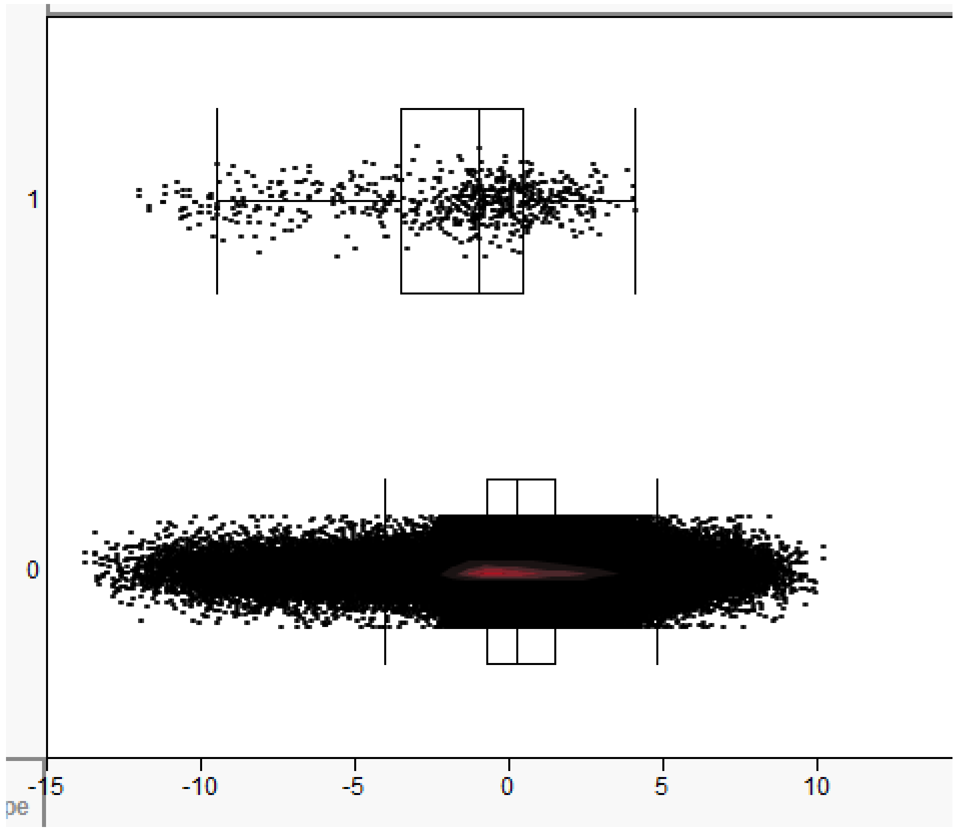

Figure 53: Y Axis is Fatal Dyadic Conflicts (1 for yes, 0 for no). X Axis is the Aggregate Index Score Measured in Standard Deviations Around the Mean

The results of a logistic regression are reported as Chi-Square values. Higher values indicate that the model fit is stronger than lower values. The five models that I test are the following: the first three models are simply the Dyadic Realist, Liberal or Cultures of Interaction Indices separately regressed against one measure of conflict. The fourth model (referred below to as "Integrated") is a simple aggregation of the three indices. The fifth model integrates Realist and Liberal indices to explore the additional contribution of the CoI Index and the lay the foundation for my forecast. Each model includes only one independent variable and one dependent variable.

I tested a range of relationships between independent dependent variables. I altered independent variables by shifting the sample size from politically relevant dyads to the full data series. I changed dependent variables by including two measures of international conflict: MIDs and the sample taken using the higher 1,000 battle field deaths threshold. See Appendix 4 for the full series of results for these tests. In general, the full integrated model (aggregating the Dyadic Realist Index, Dyadic Liberal Index and the CoI Index) performed more strongly than any of the three IR measures in isolation. The bar graph below shows the chi square results from runs of the model using only politically relevant dyads (those with a Great Power or territorial contiguity) as the filter for the independent variable and dyad years with with 1,000 or more battle field deaths. The results indicate that, for politically relevant dyads, the aggregate index (simply adding up the Dyadic Realist, Liberal and CoI Indices) produce a better explanatory model than any of the approaches in isolation.

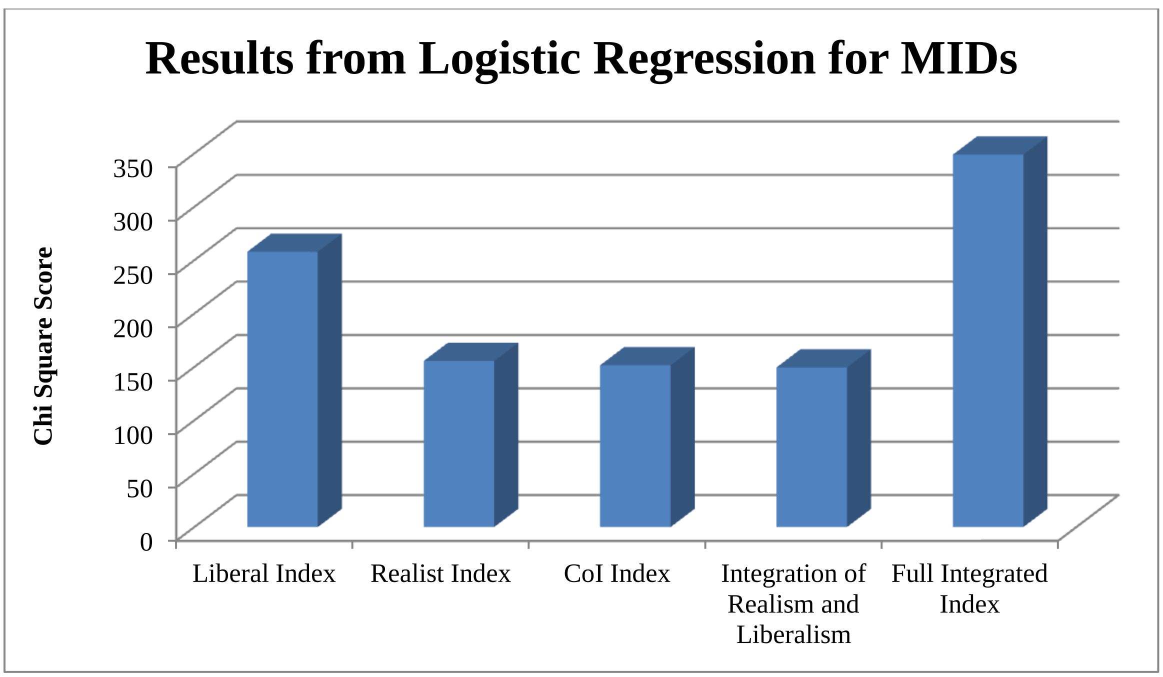

Figure 54: Logistic Regression Results: Politically Relevant Dyads and MIDs

The test results shown in Appendix 4 manipulate the independent data in the following two ways:

- Full Variables, 457k Rows: This is the full set of dyad year variables from 1960-2001.
- Full Variables with Realist Pressure 67k Rows: These include only dyad years that are politically relevant (where the dyad is territorially contiguous and/or includes one Great Power).

Each index (Realist, Liberal, CoI, Integrated with Realism and Liberalism and Full Integrated) is then regressed against two dependent variables (the low or high battle field death threshold). Out of these comparative studies, the integrated measure proved to be the most explanatory in all but one situation. The Dyadic Realist Index was of greater explanatory power when the lower battle field death threshold was used for all data points (457,000 rows). This confirms a well established fact in the quantitative study of conflict: politically relevant dyads (especially territorially contiguous) are the most likely to engage in conflict.

Overall, however, the integrated measure did a better job in predicting the historic occurrence of conflict vis-à-vis the IR indices in isolation or Realism and Liberalism combined. This quantitative test of historic data shows that an integrated approach can be more effective. It provides credibility for my theoretical framework and my forecasting methodology explored in the next chapter.

6. The Base Case of International Futures (IFs)

Introduction

Kantian Liberalism, Cultures of Interaction and Realism form the backbone of this forecast analysis. The previous chapter argued that each theoretical framework was one piece in a larger puzzle, and that emphasizing any approach in exclusion of any other would not tell as full a story about the future of international relations in the international system to 2050. I provided quantitative support for using an aggregate measure of IR theory.

This section takes these indices and explores their behaviour in the Base Case of IFs. The Base Case is a scenario that extends political and technological trends and decisions made over the last 20 years out to 2050. No large-scale technological break-through is included in this scenario (such as artificial intelligence, or cost effective carbon capture and sequestration). There are also no catastrophic events explicitly modeled (such as a massive change in natural constants) beyond those already included within historic data series that get transferred through to model structure.

In many ways the Base Case of IFs paints a positive picture of development over the next 40 years. Economic growth continues, education is expanded and health measures all improve. The grand challenges of transitioning away from fossil fuel dependence and towards renewable energy are met with little disruption to the global economy. Climate change impacts are generally small. Base Case behavior and assumptions are outline in Appendix 5, reprinted from a Human Development Report Research Paper (Hughes, Irfan, et al. 2011, 13–14).

This chapter begins by assessing the Base Case behavior of the Realist Dyadic Index. This index is measured in the same way as the Realist Index used in Chapter 5 and draws on the work of Herman and Hillebrand (Treverton 2011). Power transitions become an important piece of this analysis, and I conclude that relative material power pressures will remain a salient concern of many states over the next 40 years.

Next, I explore Kantian Liberalism's three components, spending more time documenting the treatment of Government Embeddedness in International Organizations, as this is a new addition to the IFs model. This section concludes that the world is—on whole—becoming more liberal and that this historically has been an important theoretical and empirical contributor to the mitigation of international conflict.

Third, this section explains how the Base Case treats the Cultures of Interaction Index. The CoI Index is a granular measure of dyadic alignment in the international system. As such, it cannot be endogenized within the IFs model. Instead of treating this as an internally calculated variable in IFs, I initialize data in 2010 using 2001 values, and keep them constant across time. This variable becomes the major conceptual uncertainty in this forecast and orients my further policy recommendations. Where states experience a deterioration of dyadic relations, the CoI index can mitigate this. States with the potential for deterioration should explicitly improve the sub-measures that go into the CoI

Index (align foreign policy, sign treaties and attempt to build a culture internal to the dyad that promotes cooperation).

The global average score for each of the three indices, along with the overall sum of these scores, is shown below. This highlights this chapter's general conclusion: the world is becoming less conflictual based on the combination of Kantian Liberal, Complex Liberal and Realist Indices, across time. While the Realist Index score remains relatively stagnant—indicating that overall Realist pressures are likely to persist—various forms of interdependence are on the rise. I conclude that, relying on Base Case assumptions, the future for conflict in the international system is increasingly a thing of the past.

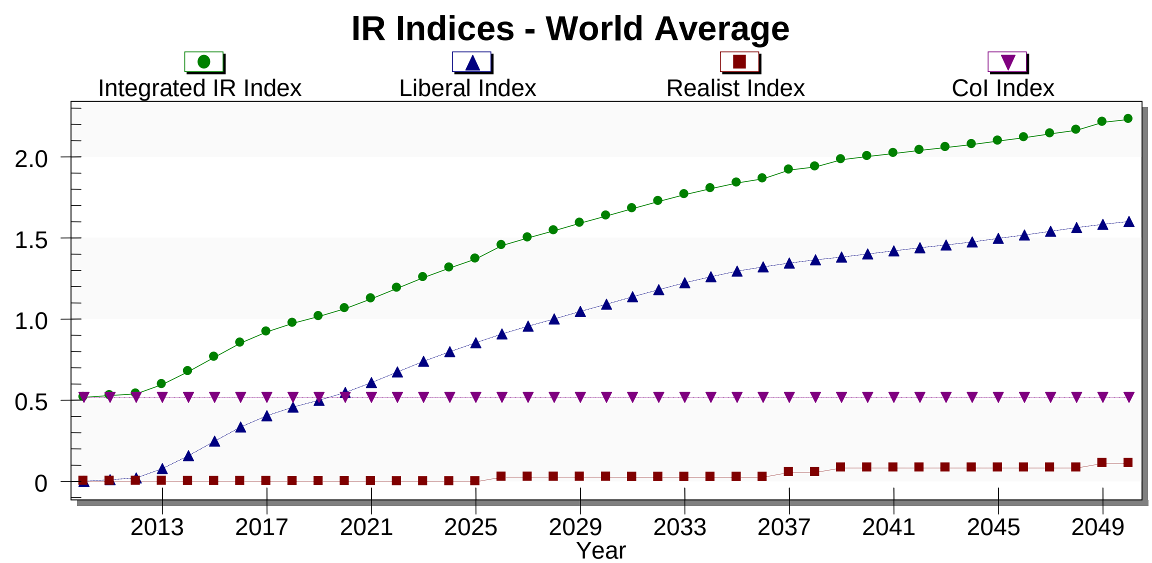

Figure 55: World Average Scores for IR Measures: Y-Axis Standard Deviations Around 2010 Mean

While, on the aggregate, dyadic relationships in the international system are forecast to improve, there are dyads and regions that are at increasing pressure from constrained resources and shifting relative power distributions. Future conflicts look likely to arise in specific dyads discussed below. The concluding section of this chapter identifies specific vulnerable groupings.

A Reminder on Measurements and Aggregations

The measurement of index scores in this chapter and their aggregation may confuse some. Most generally, readers are encouraged to remember that higher scores indicate more pacific dyadic state relationships. Lower scores—for any index or sub-index—identify more tense dyadic relations based on drivers from the specific index in question. This general rule is augmented below in the table which highlights the specific meaning of higher or lower scores for each index.

First, the output of each index is the number of standard deviations that the dyad scores for the index above or below the mean value for 2010 for the entire distribution of all dyads. The higher the score in any given index highlights the Higher scores indicate more standard deviations above the mean—and thus a better overall quality of dyadic interaction—but means specific things to each sub-index. See the table below for an overview of how different measures are treated and what higher or lower values conceptually indicate.

Table 5: Note on Measurement and Indices

	High Numbers Indicate	**Low Numbers Indicate**
Kantian Liberalism	Global norms of interdependence play strongly into dyadic decision-making	Global norms of interdependence do not play into dyadic decision-making

Cultures of Interaction	Dyad partners share high levels of bilateral affinity in foreign policy choices	Dyad partners share low levels of bilateral affinity in policy choices/are not politically relevant
Overall Realist	The dyadic distribution of resources figures little into dyadic decision-making	The dyadic distribution of material resources is important in dyadic decision-making
Overall IR Index Average	There is less overall threat in this dyad. Relations are more likely to be cooperative than conflictual.	There is a higher level of threat in this dyad. These states are more likely to be conflictual than cooperative

Aggregating dyad scores can be tricky, and done in various ways. The first way to calculate a group average score is internal to that group. In other words, take the score for each dyad within the group and average that score. The second way is across groups without over-lap. For this, I take the average Dyadic Liberal Index score for each pair of states where one member of the dyad is a member of one group and another member of the dyad is a member of the other group. An example of this is the average Dyadic Liberal Index between the BRICs and OECD groups. The third way to measure average Dyadic Liberal Index scores is to take the score of each dyad with the rest of the world. Each section below uses various aggregation methods with dyadic scores and is explicit about the approach used in each case.

Realism in IFs

The previous chapter measured and explored a Dyadic Realist Index that was based solely on relative material power distribution. Relative material power is the cornerstone of Realism. I argued that—whether you were a proponent of Power

Transition Theory of Balance of Power—that higher levels of material parity require a dyad to pay more attention to that variable across time. I begin this section by exploring the forecasted Dyadic Realist Index for relative material power.

It is the contention of this project that it is impossible to actually operationalize Realist measures of power on a macro-level scale across time because of one primary reason: there is no agreed upon dependent variable that can be operationalized. If power is the ability of A to get B to do what B would have otherwise not done, how could that be measured?

IR Realism: Relative Material Power

The relative material power index used for this analysis was describe by Treverton and Jones (2005). The index is comprised of four sub-measures, identified, with their relative weightings, below. The weightings in the index were developed through a qualitative process by Hillebrand and Herman that remains publically unavailable. The measure is identical to the historic measure used in the previous chapter.

The largest contributor to the relative material power measure in the forecast is GDP at Purchasing Power Parity (PPP). Purchasing Power Parity is used in lieu of Market Exchange Rates (MER) because, when poor countries mobilize for conflict, the resources that they are drawing on are largely domestic and not international. Using MER would undervalue these domestic assets. The next largest contribution is overall military spending, representing just less than 30% of the index. The fourth component is the overall size of the population. Population size is important and is typically a component of relative material power measures. It is most useful as a proxy for the relative number of humans that can be brought to bear in a conflict. For example, if Singapore and

Indonesia went to war—assuming that the other sub-components of the realist measure were equal—the size of Indonesia would make them a relatively stronger contender. The final measure is GDP multiplied by GDP per capita at PPP. This is a tacit representation of the technology possessed by a country. Countries and regions with high levels of technology tend to be those with high levels of GDP accompanied with high levels of per capita GDP. Large levels of GDP allow these nations to marshal resources for the development of R&D. High levels of per capita GDP indicate a work force with high levels of development.

The base-case forecast of the relative material power distribution for all countries in the world is shown below. The vast majority of countries—180 out of 183—individually have less than 5% of global material power. Only 17 countries have more than 1% of relative material power, representing less than 10% of all countries represented in IFs. The line-graph below demonstrates the widely discussed transition between great powers that is forecasted to occur in the coming decades. The top line is a measurement of the relative power of the United States. In 2012, this index measures US material power at 24% of the global total. The next line is China, whose relative material power is measured at 13%. The relative power of the US declines and China rises, with the two crossing in the decade of the 2030s. The third line—India—nearly catches up to the US by the end of the time horizon.

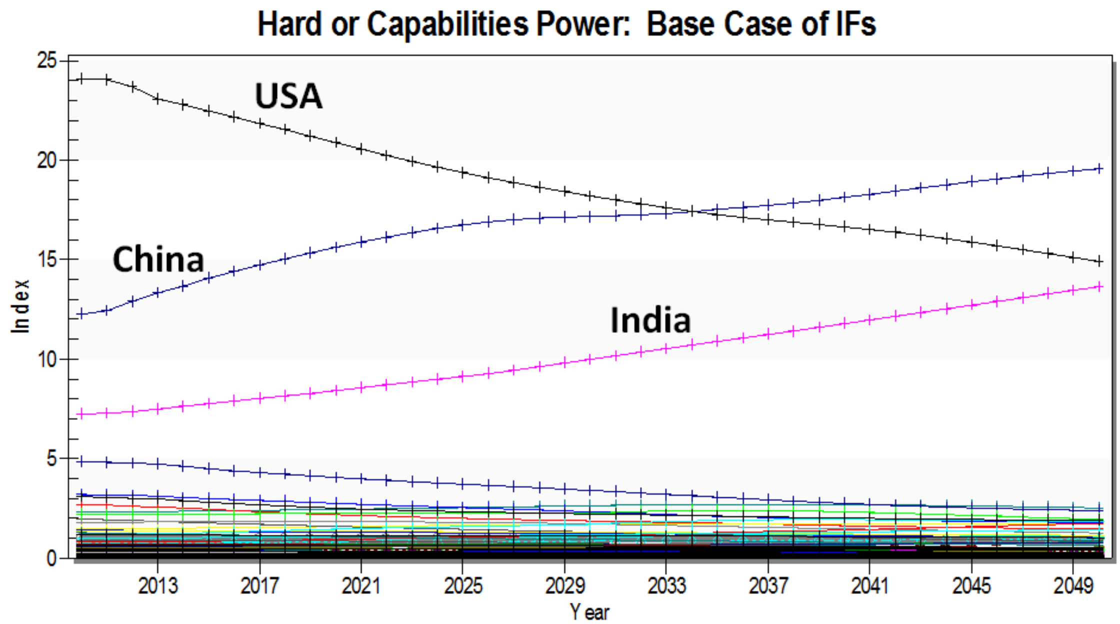

Figure 56: Relative Material Power Base Case: All Countries in IFs

The relative power transition that occurs in the line graph above reflects the sub-components of the realist index. GDP at PPP is currently largest in the US, measuring about 12 trillion dollars (in 2000 US dollars), with China and India trailing with economies of 8 trillion USD and 3 trillion USD, respectively. In the base-case, this changes dramatically. Over the total time horizon, the US economy grows at an average 1.7% annually, with China growing at 3.7% and India growing at a staggering 5%. This causes China's economy to pass the US at purchasing power parity in 10 years. India's economy is larger than the US by the end of this time horizon. In terms of population, China and India have populations that are far larger than the population of the US: India is 3.8 times the size of the US and China is 4.4 times larger. The population of China is forecast to plateau in the middle of the time horizon. This is due largely to increasing education, economic growth, and the impact of the one-child policy of the 1970s. India's population is forecast to continue growing to 2050, passing China in the early 2030s. The

US population is forecast to also continue growing through this time horizon, increasing to just over 400 million by 2050. In terms of per capita GDP at PPP, the US has the strong advantage, and this is expected to remain across the entire time horizon. US GDP per capita is nearly 40,000 per year (in 2000 dollars) and is forecast to grow to nearly 60,000 per year by 2050. China and India both have much lower levels in 2010—just over 6,000 USD and under 3,000 USD respectively. These are forecast to grow substantially, China increasing over four times its current value and India five times. The final component of the power index is military spending. Currently, the US spends more money on the military than the next 17 countries combined (nearly 415 billion USD in 2000 dollars). This is forecast to transition dramatically over the next 40 years as the green line in the line-graph below. By 2020, the US will spend more than the next 6 countries combined. By 2050, China will spend more than the US on the military. This indicates both the rise of China and her military spending but also the relative increase in equality of government military spending.[50]

[50] The GINI coefficient for government military spending in IFs is the following: 2010 = .76; 2020 = .69; 2030 = .65; 2040 = .62 and 2050 = .59

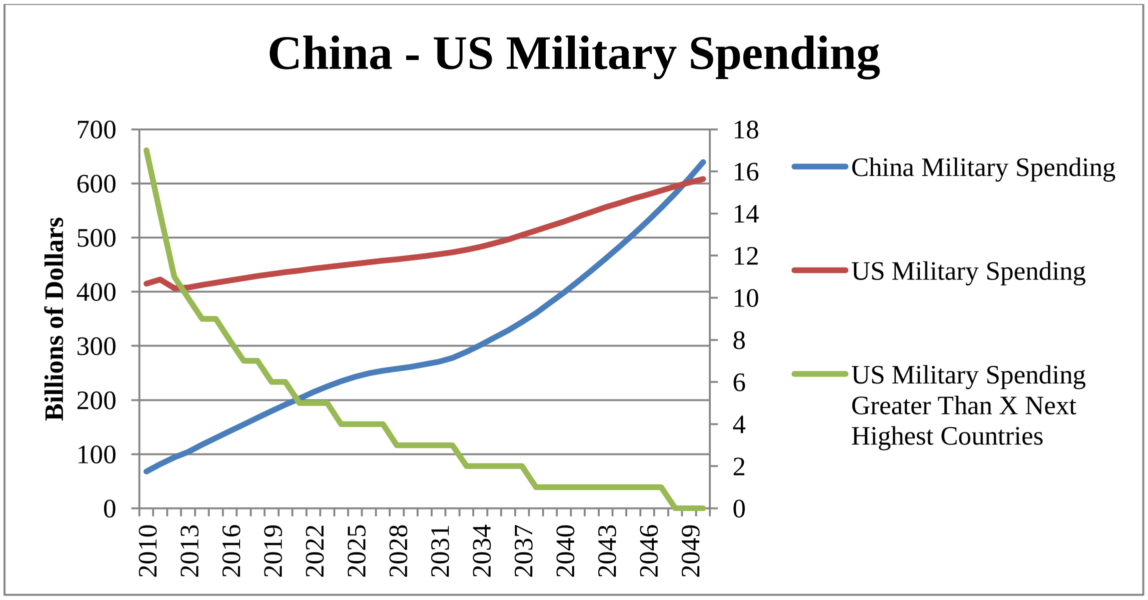

Figure 57: US and China Military Spending with US Distribution of Global Spending: 2000 US Dollard at MER

The time horizon begins with nine countries above the base-case threshold for identifying a great power: 2 percent of total relative global material power. These are, in order from most power to least, the US, China, India, Japan, Germany, United Kingdom, France, Brazil and Russia. By the end of the time horizon, the number of great powers is reduced from nine to five. The remaining powers are, in order, China, USA, India, Brazil and Japan. The distribution of power in the international system is currently largely in the hands of the US, with China and India growing rapidly. Membership in this group remains the same. The next most powerful countries—those that have considerable material resources but are not in the same class as China, India and the US—are whittled down across time by growth in both the top three Great Powers, and the rest of the world. This is indicated in the line graph below. Currently, the top three have nearly 45 percent of the world's material power, increasing over time to nearly 50 percent. The rest of the world grows slightly, and ends the time horizon with 40 percent of the world's power.

The second-tier Great Powers, however, see their relative material resources decline from less than 20 percent of the world's power to just over 10 percent.

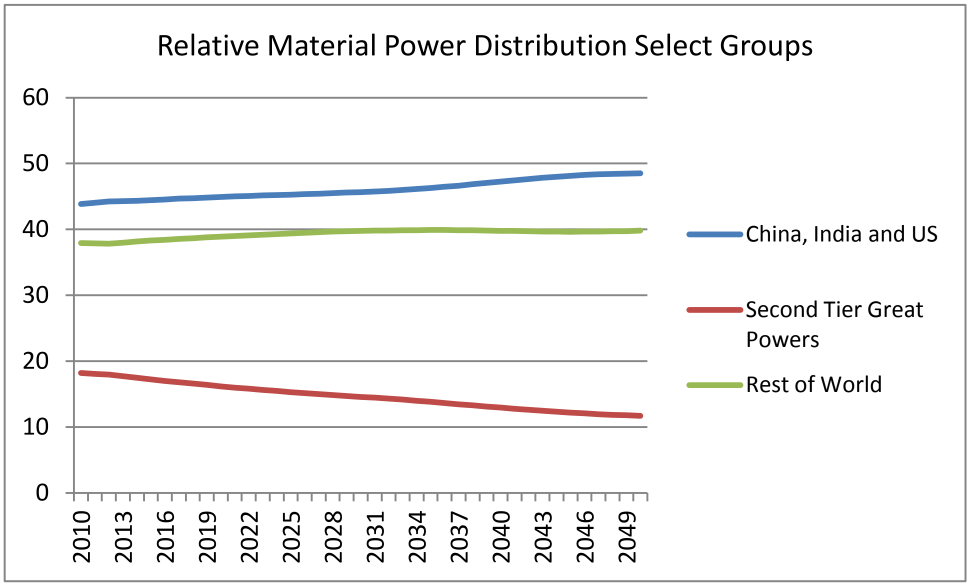

Figure 58: Relative Material Power for Great Powers, Second Tier Powers and Rest of World

Twenty three countries out of 183 double their relative material power across the time horizon. The greatest relative improvement occurs in Turkmenistan and Angola, which see their power increase by a factor of more than 3.5 times. Of the 23 countries that double their power, 17 are African. At the other extreme, six countries experience their power cut in half. They are all European with the greatest reduction in power occurring in Montenegro, Italy and Greece.

The Dyadic Realist Index forecast was measured in the same way as the historic measure. In the first year all dyads were first separated into either politically relevant dyads or non-politically relevant dyads. This was done by an algorithm that considered two things: first, whether there was a great power in the dyad (measured as having 2 percent of global material power) and secondly whether the dyad was territorially contiguous. If either of these criterion were met, then the relative material power as a percentage of the less endowed member of the dyad was divided by the more endowed member.

Higher Dyadic Realist Index scores indicate that relative material power distribution is less of a decisive issue in decision making between a pair of states. Incrementally lower absolute values of the Dyadic Realist Index indicate that relative material power distribution increases in importance in decision-making across the dyad-year, *ceteris paribus*. The absolute value of the Dyadic Realist Index measures the number of standard deviations above or below the mean for the total dyad-year distribution in 2010.

Globally, the average of all Dyadic Realist Index scores measuring material power proximity increases in absolute terms, indicating a decline in the degree to which questions of relative power distribution are an important piece of decision making, *ceteris paribus*. This is because the number of states classified as Great Powers reduces, and this lowers the total amount of relative material power pressure in the system. In the base-case of IFs, four countries begin the time horizon as great powers (having more than 2 percent of global material power) but end the time horizon as non-great powers: France, Germany, Russia and the United Kingdom. By 2050 the base-case of IFs shows five great powers: China, with 20 percent of material power, the US with 15 percent, India with 14 percent, Brazil with 3 percent and Japan with 2 percent.

By removing the four falling Great Powers, the Average Dyadic Realist Index demonstrates a slight decline in the absolute value. Lower absolute values indicate an increase in overall, global realist pressure. In the Base Case, this is forecast to be relatively small, changing by only 0.001 standard deviations. The forecast is consistent with Realist claims of the continued relevance of material power distribution in decision making and is also consistent with historic trends in average Dyadic Realist Index scores remaining relatively static across time.

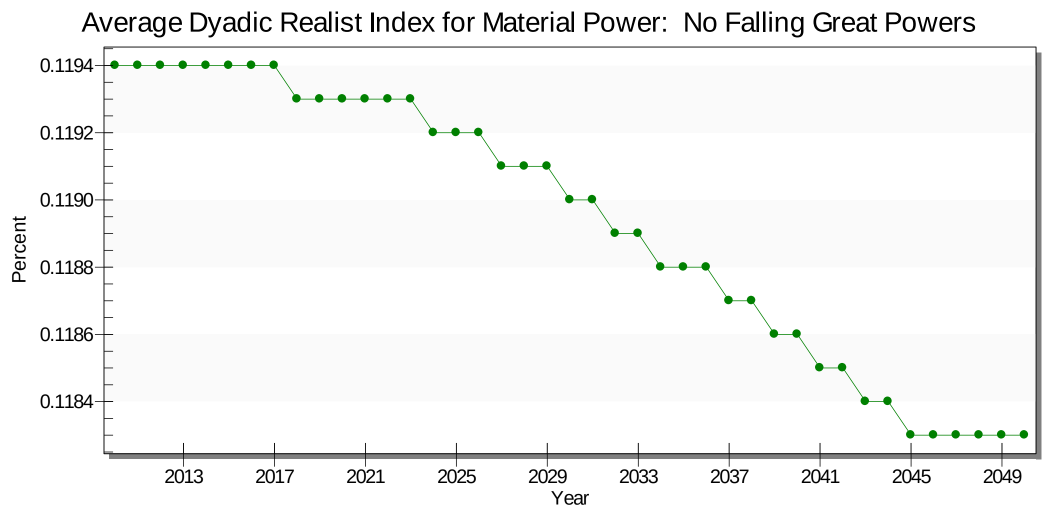

Figure 59: Dyadic Realist Index for Relative Material Power - No Falling Great Powers

Moving from the global average of all Dyadic Realist Index scores to average country-year scores tells a story first about Great Powers and non-Great Powers. To take country-year scores, I averaged each dyad-year score for each of the 183 countries modeled in IFs. This measure indicates the degree that—in general and across time—a country makes foreign policy decisions that consider relative material power distribution, *ceteris paribus*.

The average score for all non-Great Powers (not including the four that fall below the Great Power threshold in the time horizon) is 0.156, well above the mean, indicating that relative matieral power figures into only a limited amount of foreign policy decisions. The average for Great Powers across the time horizon (including the four that fall) is -2.09, two standard deviations below the mean, indicating that power distribution is an important component of foreign policy decision-making. This is the result of the modeling strategy—informed by IR theory—which argued that Great Powers would need to consider the material distribution between themselves and all countries in the international system while countries who were below the Great Power threshold would only need to be concerned with the power distribution between themselves and their neighbors.

The average Dyadic Realist Index scores Across time, this pressure dissipates for the four countries that fall out of the Great Power category: Russia, France, United Kingdom and Germany. Across time, four former Great Powers become non-Great-Powers. This should decrease the amount of time focused on making decisions around the role of the distribution of material resources in the international system ceteris paribus. In modeling terms, these four countries experience the largest abslute increase in their average Dyadic Realist Index scores, indicating that they experience a very large reduction in the degree that material power plays into their foreign policy, *ceteris paribus*.

Removing Great Powers from the analysis, the majority of countries experience little or no change in their average Dyadic Realist Index scores across the time horizon. The line-graph below takes the absolute change in the Dyadic Realist Index from 2010 to 2050 for each country and sorts them by most increase to most decrease, moving from left to right. It shows that the majority of states in the international system—92 out of 183—will see the importance of relative material power remain within 0.005 standard deviations of where it is in 2010, *ceteris paribus*.

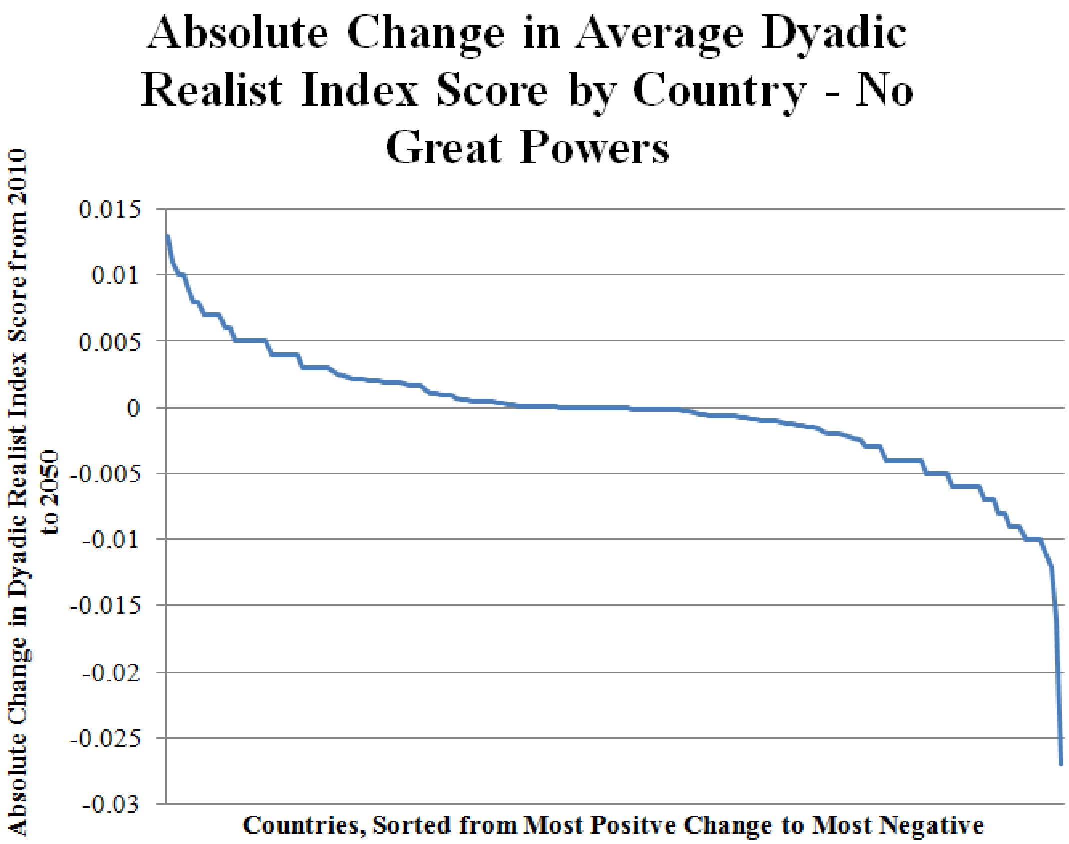

Figure 60: Absolute Standard Deviation Change by Country - No Great Powers

At the extremes, there are two groups: those who are forecast to see the importance of relative material power decrese and those who are forecast to see it increase. The five countries that experience the greatest absolute increase in the index score—signaling a declining importance for relative material power in foreign policy—are (in order from greatest absolute increase) Zambia, Jamaica, Oman, Portugal and Zimbabwe. However, the greatest improvement is only 0.13 standard deviations. The countreis with the greatest absolute decline in their average Realist Index scores are (again, in order) Turkmenistan, Iran, Ghana, Algeria and Nigeria. The greatest change here is a -0.25 standard deviation decline in the score.

The non-Great Powers with the lowest average Dyadic Realist Index scores that indicate that their decisionmaking is largely oriented towards relative material power considerations are Saudi Arabia, Turkey, Iran, Egypt and Libya. The five countries with the highest scores are Cape Verde, Grenada, Maldives, Micronesia and Samoa.

Moving from average country-year scores to dyad scores provides an additional level of granularity. Of the total number of dyads in the sample—over 33,000—only 8 experience a deteoriation in dyadic material power that is over one standard deviation. These are the following dyads, ranked from most deterioration to least.

Table 6: Dyads with Material Power Deterioration

Dyads with Deterioration in Realist Relative Material Power Measure of Greater than 1 Standard Deviation	
Turkmenistan	Kazakhstan
USA	India
Nigeria	Japan
Uzbekistan	Turkmenistan
Japan	Brazil
UAE	Qatar
Saudi Arabia	Japan
Pakistan	Japan

The greatest transition occurs between Turkmenistan and Kazakhstan. Kazakhstan is currently nearly four times as powerful as Turkmenistan. However, Turkmenistan is forecasted to fully make up that difference in relative material power and be nearly at material power parity with Turkmenistan over the coming decades.

Table 7: Dyads with Improvement in Material Power Less than 1 Standard Deviation

Dyads with Improvement in

Realist Relative Material Power Measure of Less than 1 Standard Deviation	
Portugal	Morocco
Italy	Brazil
Japan	India
Zimbabwe	Zambia
Yemen	Oman

Liberalism in IFs

The world is becoming more liberal, in the Kantian sense. Global trade is increasing, levels of democracy continue to rise and international organizations and treaties are an increasingly relevant way to solve collective action problems and disagreements in the international system. This kind of interdependence—not characterized by bilateral interdependence but rather dependence to the international system as a whole—is radically shifting how states behave.

The section explores the construction and behavior of the Dyadic Liberal Index, comprised of measures of trade, democracy and embeddedness in international organizations. I begin by documenting the structure of the international organization embeddedness (GOVEMBED) model within IFs. The construction and behavior of this variable is focused on more thoroughly than other variables that make up the Dyadic Liberal Index because it is new to the IFs system and it requires documentation. Next, I highlight the general structure and behavior of both democracy and trade in IFs.
This section ends by identifying the construction and behavior of the base-case Dyadic Liberal Index from 2010 to 2050 in IFs. It concludes that, if base-case assumptions are

upheld, that the majority of dyadic relationships will improve their levels of Kantian Liberalism. While some dyads remain highly illiberal and even become less liberal across time, they represent a small handful—less than 5%—of all dyads in the international system. I also conclude that, while IFs forecasts great improvement in levels of dyadic Liberalism across time, that great discrepancies across regions will remain even over the next four decades.

IR Liberalism: International Organization Embeddedness in IFs

Prior to this dissertation, two of these legs of the Kantian tripod were forecasted within the IFs system: democracy and trade. One contribution of this project is a forecast of country embeddedness in international political systems. Thus, this section will treat the later variable in much more depth, as the former two variables have been discussed elsewhere (Hughes, Joshi, et al.; Hughes, Hossain, and Irfan 2007).

Throughout this project I have referred to the third leg of the Liberal tripod as "embeddedness" in international political systems. In *Perpetual Peace* Kant identified belonging to a "federation of states" as being an important driver of pacific relations (Kant 1991). The third leg has been measured by looking at membership in IOs (Pevehouse and Russett 2006; Russett, Oneal, and Davis 1998). "Embeddedness" in international organizations is meant to signal the degree to which a country has committed itself to overcoming collective action problems (among other international issues) through the world of international organizations and agreements.

I measure country-level embeddedness in international political institutions by exploring two kinds of data that are conceptually related. The first is membership in international organizations. The second is country commitment to UN treaties through signing or ratification.

There is a relationship between both the IO and UN measures, though it is far from linear. The cross-sectional plot below highlights this, and places the measure of UN treaties on the x axis and the IO membership on the y axis. It separates countries into their UN Population categories and fits a second degree polynomial curve to this relationship. The r^2 value is .55. This shows that North American, Latin American and African countries are more likely to join IOs than sign UN treaties relative to the fit of the curve. The opposite is true for European, Asian and Oceanic countries.

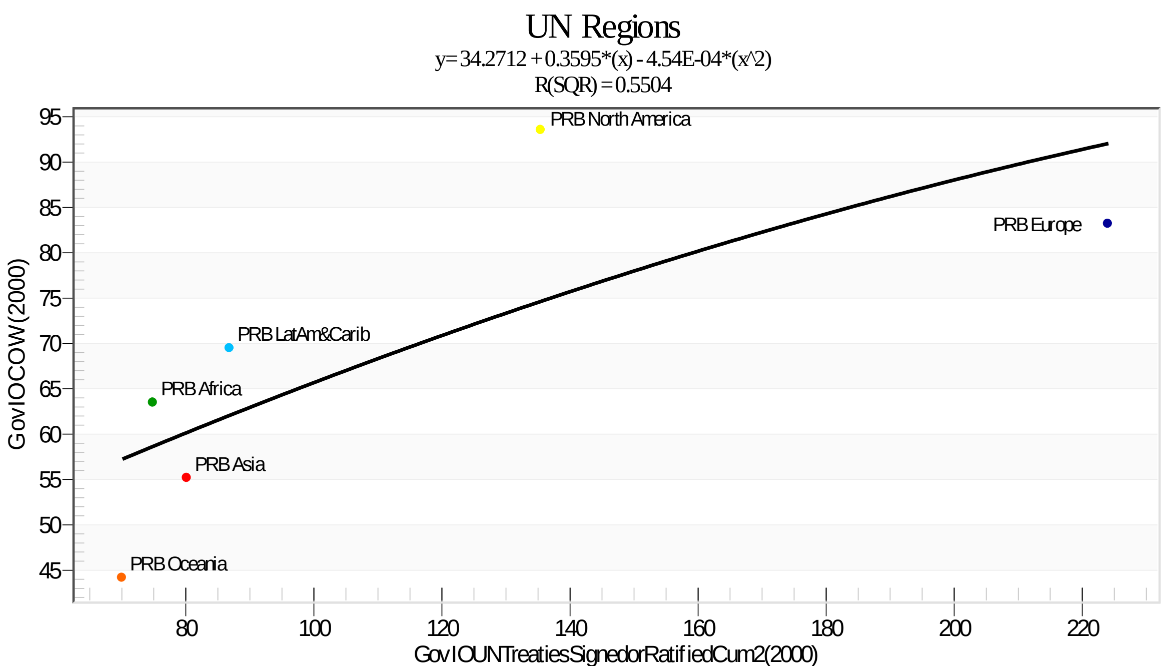

Figure 61: Cross-Sectional Relationship Between UN Treaty Scores and IO Membership

To forecast IO embeddedness, this project creates an index that combines impacts from both IO and UN Treaty scores. In the process of creating this index I was unable to find guidance as to how to relatively weight IO membership to UN treaty signatories/ratifiers. I decided to weight them generally "equally", where the absolute average number of IO memberships should be weighted about as much as the total UN treaty score. UN treaty scores were generally five times larger than IO embeddedness scores for countries in the most recent years with the largest overall embeddedness. Thus, and fairly arbitrarily, signing 5 UN treaties or signing one and ratifying two signals the same level of embeddedness in international political organizations as being a member of one international organization.

The overall index—referred hitherto as embeddedness in international political organizations—is graphed below. The historic pattern is similar to the growth pattern of both IO membership and UN Treaty scores, both graphed above. Again, we see the global average score increase at the end of the Cold War which is an impact that stems from the UN Treaty data, and not the IO membership data.

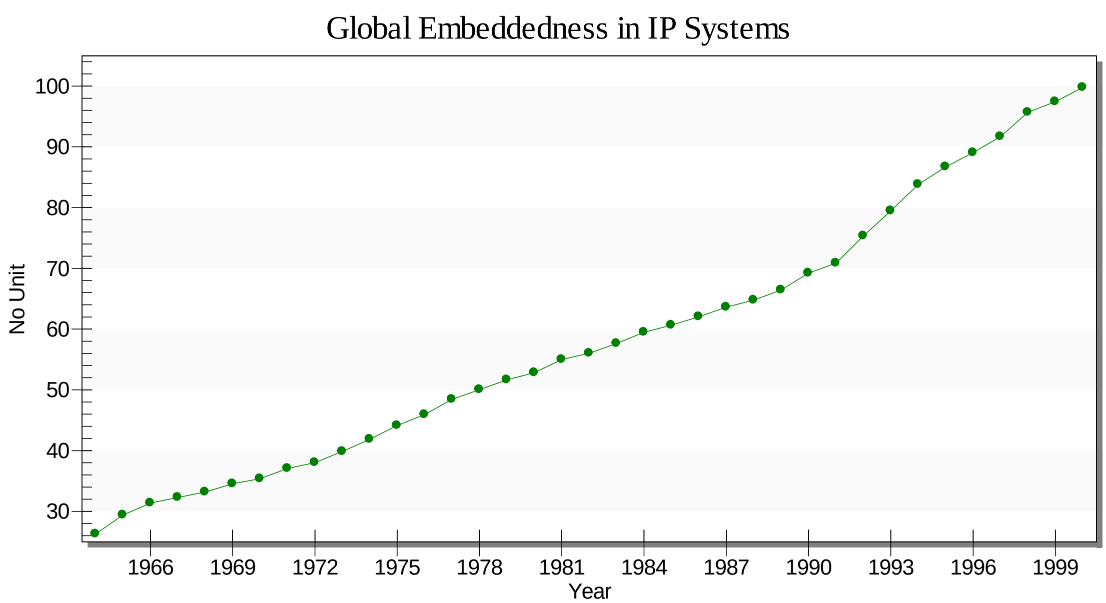

Figure 62: Global Average Country Embeddedness in International Political Systems

There are no quantitative forecasts of embeddedness in international political organizations, to my knowledge. This project, therefore, breaks new ground. The following section outlines the initial logic for forecasting this variable, some results and then limitations. This forecast is a work-in-progress, and welcomes constructive and creative criticism. The model that I constructed to forecast this variable included three key drivers at this initial stage in the process, and should likely be augmented with an algorithmic treatment of great powers at a later stage.

To forecast this variable I began with a conceptual account of why countries embed themselves in international organizations and sign UN treaties. Neo-Liberal Institutionalists have long claimed that such behavior is designed to change the cost of decision-making in the international system to help overcome collective action problems and signal trust-worthiness in anarchy. Following this logic, we should expect that countries that are more willing to embed themselves in international organizations have some resources that they would like to preserve and the means to preserve these resources. With this in mind, I went about building a statistical model.

I explored numerous relationships between variables that I felt had conceptual salience for the forecast of embeddedness in international political institutions. I found the strongest statistical and conceptual model to include the following drivers: income per capita at purchasing power parity, government expenses as a percentage of GDP and a measure of relative material power[51]. I will explore each of these variables in turn, and then will turn to the combined model.

The cross-sectional plot below maps the relationship between GDP per capita at purchasing power parity and the measure of country embeddedness in international

[51] Relative material power is an index constructed in IFs that measures levels of income, population size, technological competence and governance effectiveness.

political institutions. The relationship not insignificant (with an r^2 of 0.26) and an upward sloping curve. Here, we expect countries with higher incomes to embed themselves more in international political institutions.

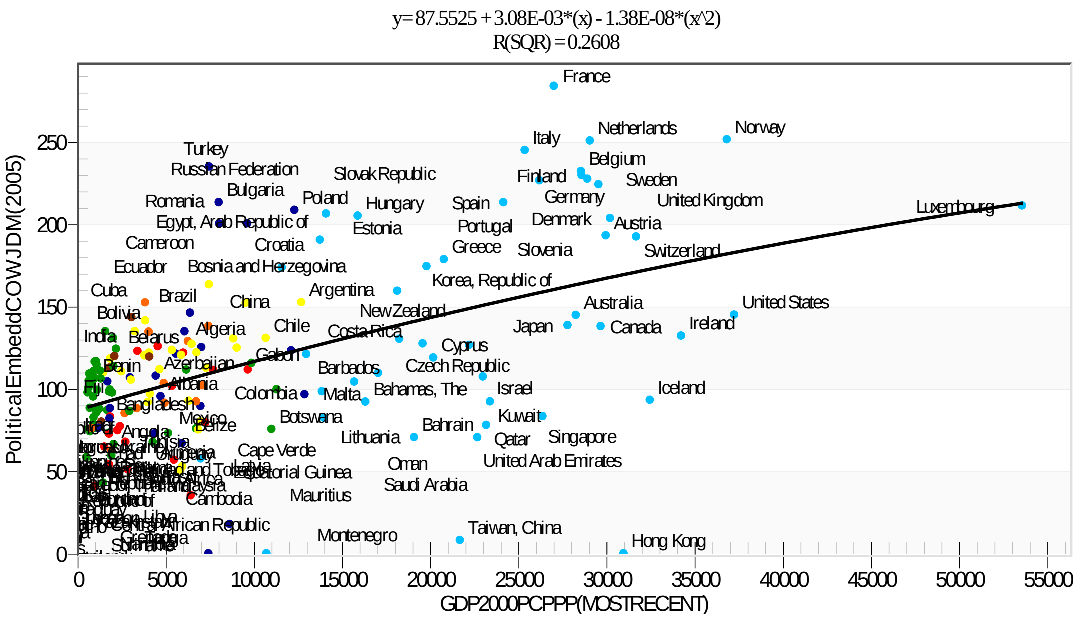

Figure 63: Cross-Sectional Relationship Between GDP Per Capita at PPP and Country-Level Embeddedness in International Political Systems

High income indicates that countires are likely to have the resources to invest in embedding themselves in internatioanl organizations (it takes resources to staff IOs and enforce laws that stem from UN ratification, for example). However, having material resources alone doesn't necessarily indicate that the country in question is willing to spend these on international organizations. For a measure of country willingness to invest in bureaucratic solutions to problems, I plotted government expenditures as a percentage of GDP against my measure of embeddedness in international organizations. That scatter-plot is below. The r^2 is 0.22, and the curve is upward sloping. This indicates that, as the porportion of the GDP that comes from governmental expenses increases, we would expect them to be more embedded in international political systems.

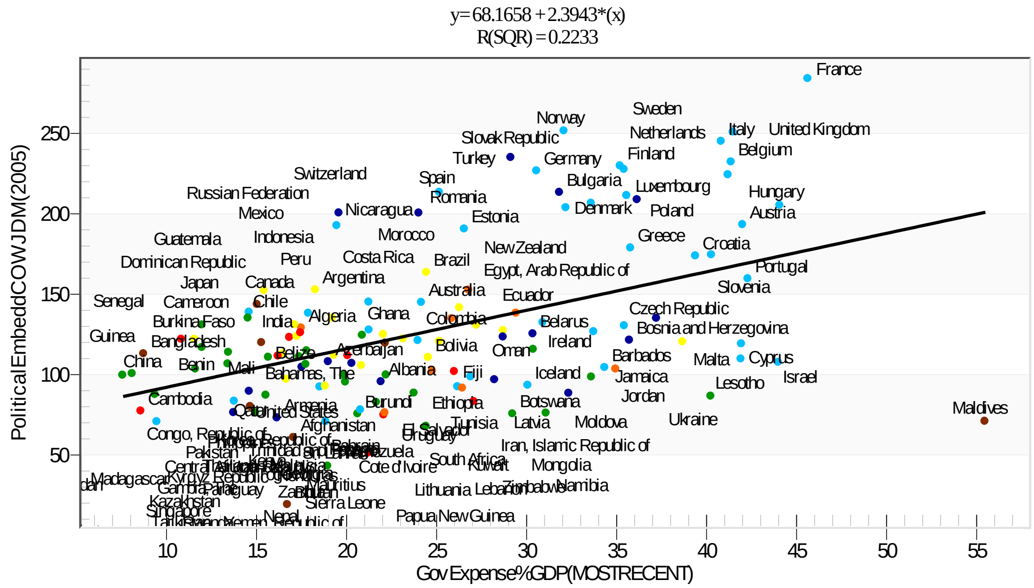

Figure 64: Cross-Sectional Relationship between Government Expense as a Percentage of GDP and Country-Level Embeddedness in International Political Systems

The third variable in this model is realtive material power, which is a measure of income, population, technology and governance quality that is placed on a relative scale of 0-100. The scatter plot below plots this with international political embeddedness. The r^2 is very low (0.065), but the variable has a very significant contribution to the multivariate model. The scatter-plot below highlights the upward sloping curve, and indicates that, as countries have more material power, they are increasingly willing to embed themselves in international political institutions. There may be a separate set of relationships for Great Powers, tentatively identified in the graph below as the US, Japan, China and India (any country with over 5% of global power). This issue is discussed later.

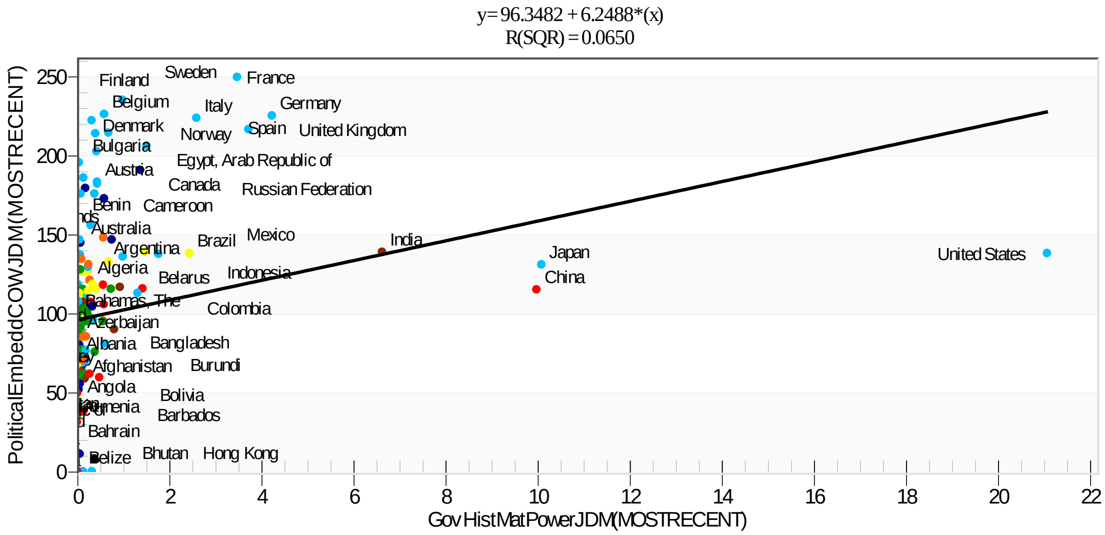

Figure 65: Cross-Sectional Relationship between Relative Material power and Country Embeddedness in International Political Systems

The adjusted r^2 is .59, which is reasonable, and t and p values are all within the range of significance. The specific data series used for this model are also identified in Appendix 8—along with all statistical scores, which are significant. The equation used to forecast this variable is the following:

*International Political Embeddedness = 57.1 + (.00192 * GDP per capita at PPP) + (1.443 * Government Expenses / GDP) + (18.378 * Relative Material Power)*

Analyzing the results of this… The initial forecast of this variable indicates that the overall trend in embeddedness in international organizations is likely to continue to grow across time. The line graph below highlights this by identifying the history and forecast of embeddedness in these international political organizations for key UN regions to 2050. The average score in the highest region (Europe) is nearly 200. Latin

America and Asia will surpass this value sometime in the 2020s. Africa will nearly reach this value by the end of the time horizon.

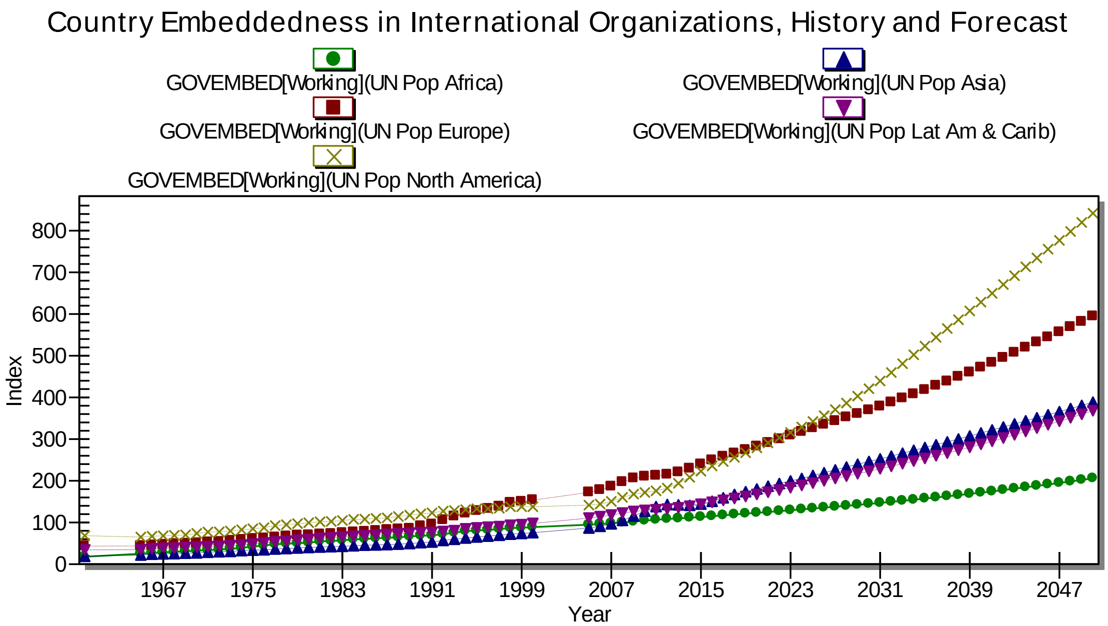

Figure 66: History and Forecast of Country Embeddedness in International Political Systems for UN Population Groupings

The distribution of IO embeddedness across time highlights that, even with the relatively optimistic IFs forecast, that some central African countries will have the same overall commitment to IOs in 2050 that places in Europe had achieved by the 1960s. A series of maps by decade can be found in Appendix 5 that highlight these transitions across time. The legends in the map are fixed, so values and colors are comparable temporally. The map below shows the global distribution of IO embeddedness in 1960.

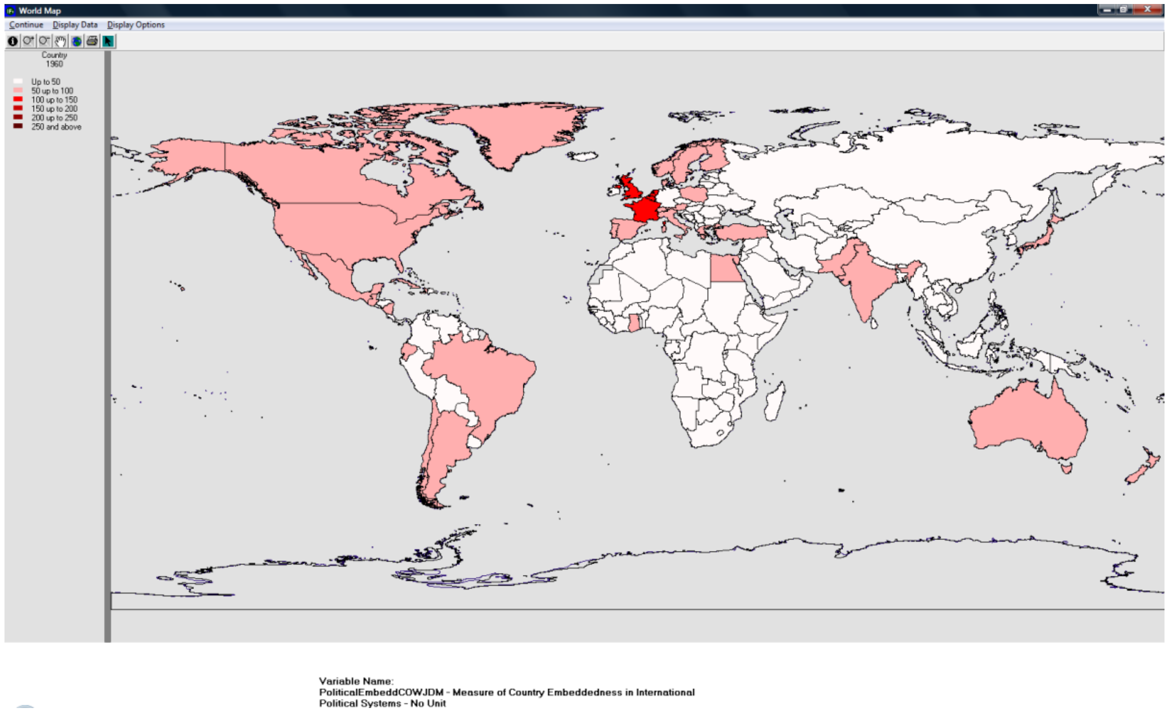

Figure 67: Country Embeddedness in International Political Systems - 1960

All countries on this map fall into the lowest three categories of IO embeddedness, representing scores of 0-50, 50-100 or 100-150. Only four countries achieve the 100-150 score range: Britain, France, Belgium and the Netherlands. Countries with higher levels of embeddedness are mostly in Europe as well as North and South America. There are a handful of countries in Asia, and only two in Africa with scores that are higher than the 0-50 range (Egypt and Ghana).

The distribution changes dramatically over the next 40 years. See the map below of the distribution in 2000.

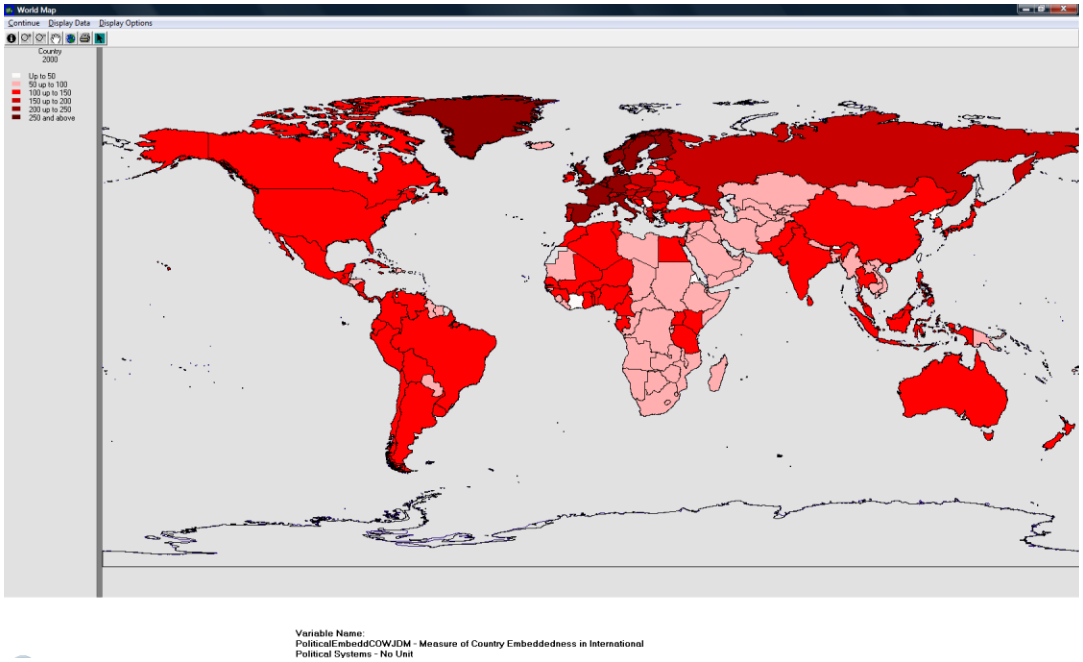

Figure 68: Country Embeddedness in International Political Systems - 2000

Here we see four categories of country embeddedness in IOs, ranging from scores of 250-200, 200-150, 150-100, 100-50 and 50-0. In the highest score range, we find many Western and Northern European countries. Moving to the next rage finds some Eastern European countries and Russia. A large number of countries are found in the third and forth categories. The third category—the same level of embeddedness as Britain, France, Belgium and the Netherlands experienced in 1960—we find China, India, the US and most of South and Central America. There are also pockets of this level of embeddedness in Western Africa. For the next level—scores between 100-50; the same level of the US in 1960—we find much of the Middle East, Central Asia, Central Africa, Southern Africa and pockets of South East Asia and Eastern Africa. There are only two fully sovereign nations in 2000 that had levels of commitment that were in the lowest range: North Korea and Sierra Leon (Taiwan and Western Sahara appear as white in the map above, but lack full sovereignty).

Shifting our attention to the forecast for 2050, a much fuller picture emerges of country embeddedness in international organizations. See the map below.

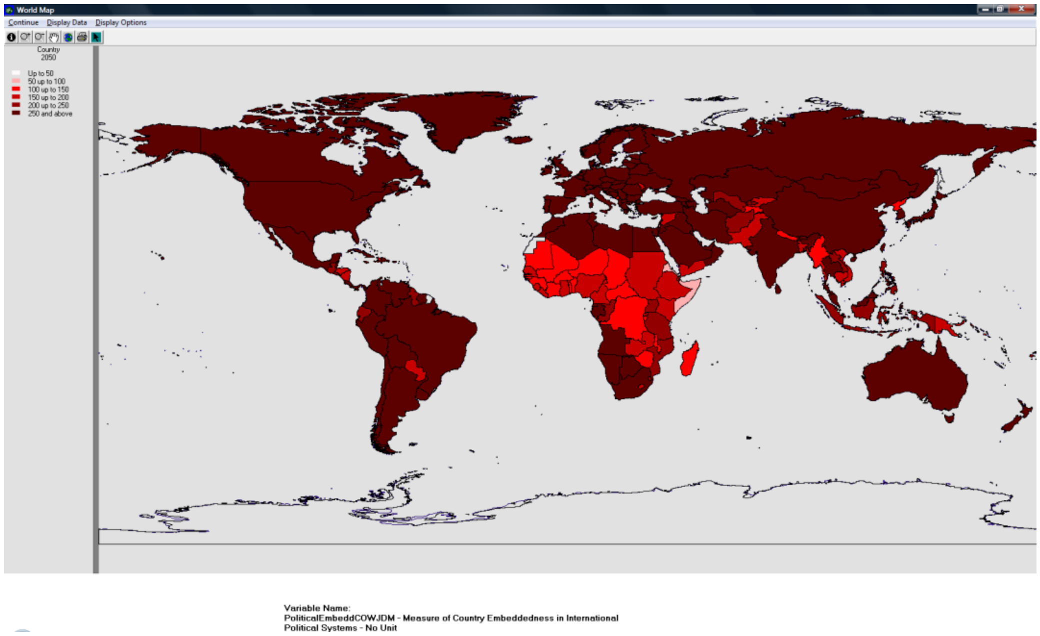

Figure 69: Country Embeddedness in International Political Systems - 2050

Here we see the vast majority of members of the international system having levels of embeddedness that are higher than what we have seen for any member in the year 2000. The embeddedness scores from 2000 to 2050 are forecasted to growth substantially, with average scores in Europe targeted to be nearly 600, and almost 900 in North America. While wide-ranging growth in embeddedness in international organizations is forecasted in this scenario, there are still pockets of very low levels of embeddedness and commitment to IOs. Much of Central and Western Africa are forecasted to have levels of embeddedness that score between 100-150, the same category that we found France, Britain, Belgium and the Netherlands in 1960. Other notable low-scoring countries are Burma, Nepal, North Korea and Tajikistan. At the very low end, the model created for this project forecasts that Somalia, Eriteria and East Timor have levels of embeddedness in 2050 that are the same as India, Poland, Turkey, Ghana and the US in 1960.

This approach to forecasting IO embeddedness is obviously not without its problems. One key issue is the treatment of countries with very high levels of relative material power (defined earlier in this paper). China, Japan, India and the USA are currently the four countries with the largest relative material power resources. Historically, these four countries were reticent to join IOs. Because our forecast has these four countries continuing with relatively strong economic growth, there is very strong growth in embeddedness. The line graph below highlights this problem.

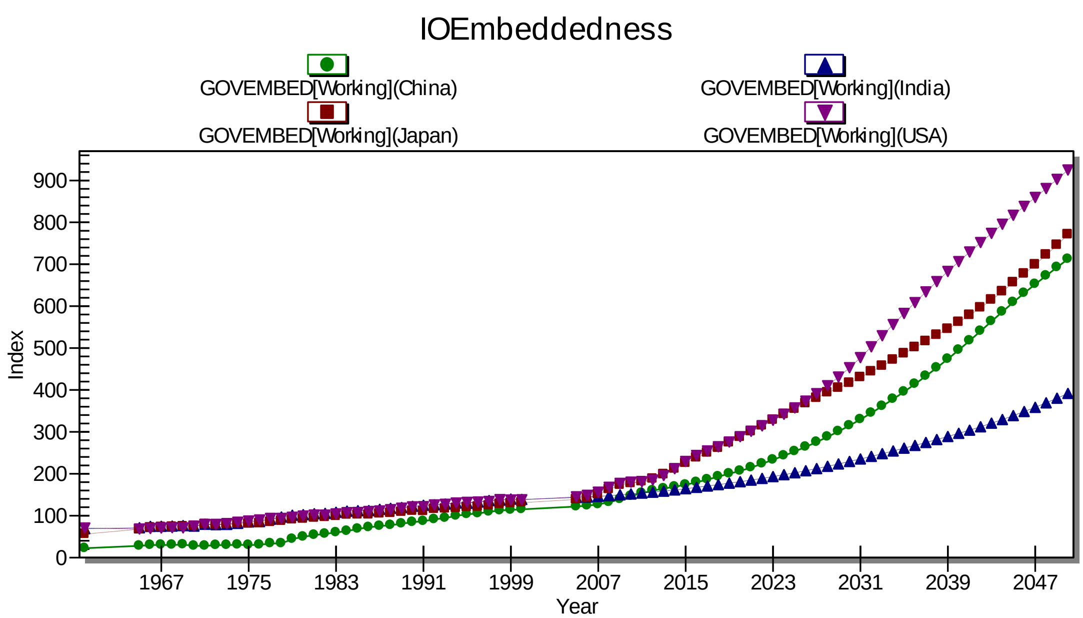

Figure 70: Country Embeddedness in International Political Systems - Key Great Powers

It is very likely that countries with very high levels of relative material power will feel less of a need to project their interests through these international organizations. Instead, they are likely less interested in binding themselves to international bureaucracy and more interested in being able to go-it alone. Anecdotally, we can see this transition in the historic data on Russian embeddedness in international organizations. Prior to opening their economy to increased market pressures and eventually moving away from state based mechanisms of distributing surplus value, the USSR had relatively low levels of embeddedness in these international organizations. This is particularly seen in the data on UN embeddedness, shown below.

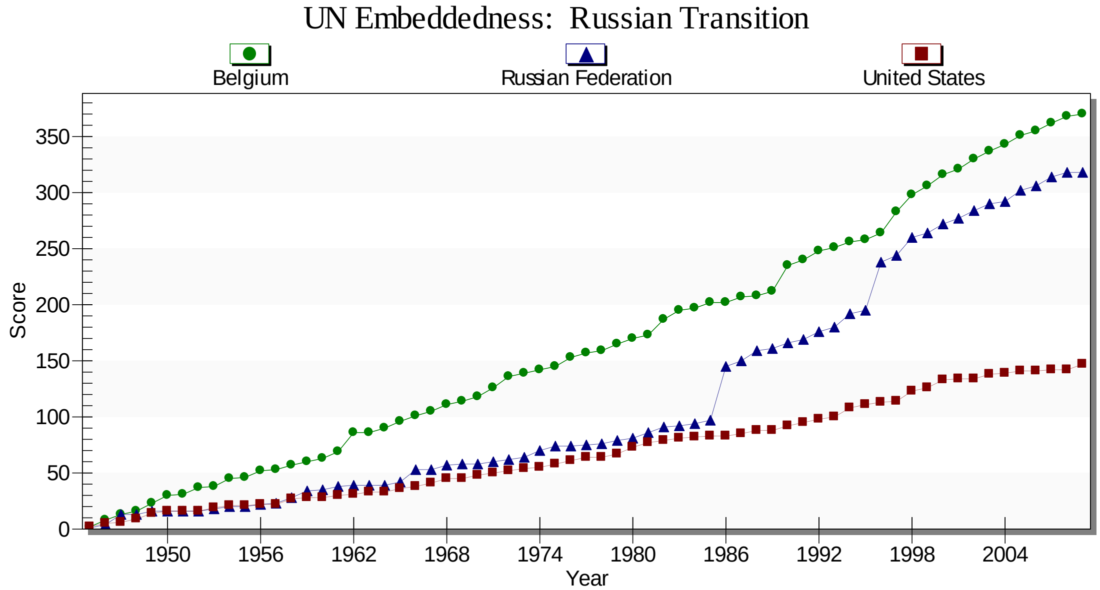

Figure 71: UN Treaty Embeddedness - Russian Transition at End of Cold War

In the line graph above, Belgium represents one of the most committed countries to signing and ratifying UN treaties across time. The US, as a great power, it is argued, may feel less obligation to projecting interest through such institutions, and has lower absolute levels of embeddedness in these treaties across time. Russia experiences a transition as they move through the process of opening the country to outside influence in the middle of the 1980s. This graph could be interpreted as Russian acknowledgement that their reliance on their great material strength to project influence was waning, and that they would have to further rely on international institutions to work for change in the international system.

IR Liberalism: Democracy in IFs

The current treatment of governance within the IFs model focuses on a path dependent treatment of the diffusion of pluralistic governance regimes driven by levels of income and levels of educational attainment. The forecast variable is the Polity score that has been tailored to range from 0 (autocratic) to 20 (democratic).

Forecasting levels of democracy is not simple. A cross sectional relationship between Polity's Democracy measure and GDP per capita at PPP yields an r^2 of 0.20. While many countries with high incomes are also democratic, exceptions exist (Singapore, Kuwait, among others). On the other end, there are many countries with high levels of democracy but with very low levels of income (India, Mongolia and Paraguay, for example).

The total number of years of education that a person has in a country is also related to levels of democracy. This relationship is slightly more robust with an r^2 of 0.29. While most countries with the very highest levels of education are democratic (Sweden, Australia, Germany, Canada all score 10) there are some outliers (South Korea scores an 8). There is much more variation among countries with low levels of education and democracy, with countries like Mali and Burundi having very low education but scoring a 7 on the democracy scale, and other poorly educated countries like Rwanda and Sudan scoring 1 and 0 respectively.

Combining GDP per capita at PPP with the average number of years a person has at 15 yields a higher r^2 than either in isolation (0.40).

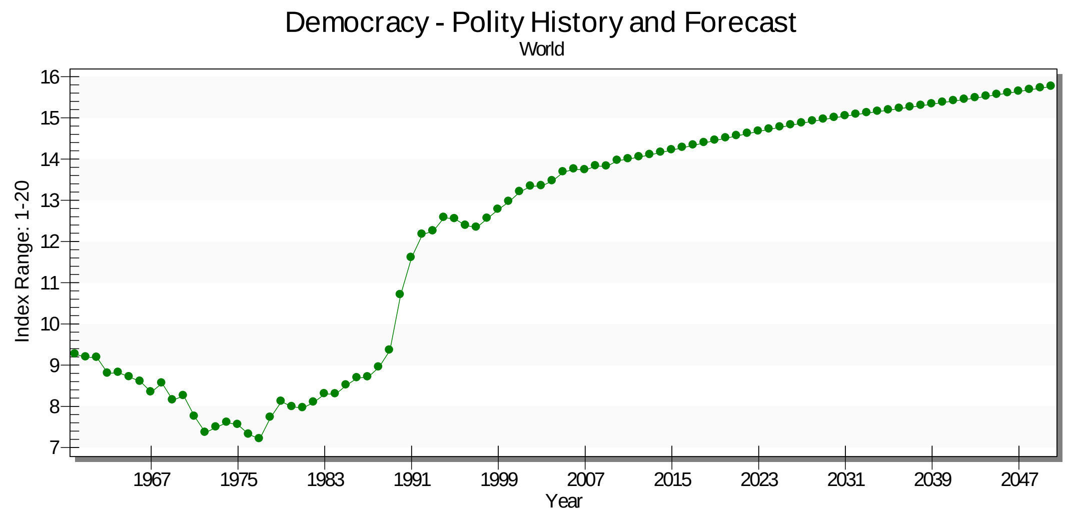

Figure 72: Global Democracy - History and Forecast

IR Liberalism: Trade in IFs

To understand the IFs forecast of trade it is important to understand—at least in general terms—the economic model structure. Productivity is endogenized in a Cobb-Douglas production function with insights from Solow (1956) and Romer (1990) where improvements to labor interacting with capital derive from three sources: human capital development, social capital development and physical capital development. The IFs economic model is a 6 sector model (manufacturing, services, materials, agriculture, energy and ICT) which are all initially aggregations of GTAP data (Hertel 1997) whose relative shares shift dynamically based on levels of development. These sectors interact with actors in a market, where firms, governments and households (skilled and unskilled) buy and sell goods and prices "chase" equilibrium. This interaction is enveloped within a Social Accounting Matrix (SAM) structure (Leontief 1966).

Trade levels are forecasted using a pooled approach in contrast to a bilateral approach. This pooled approach works by determining both import and export potential for all sectors and all countries. Total global demand for trade by sector is also then determined. These two are normalized using something. Armington elasticities are also important in identifying and determining longer term patterns of trade (1969).

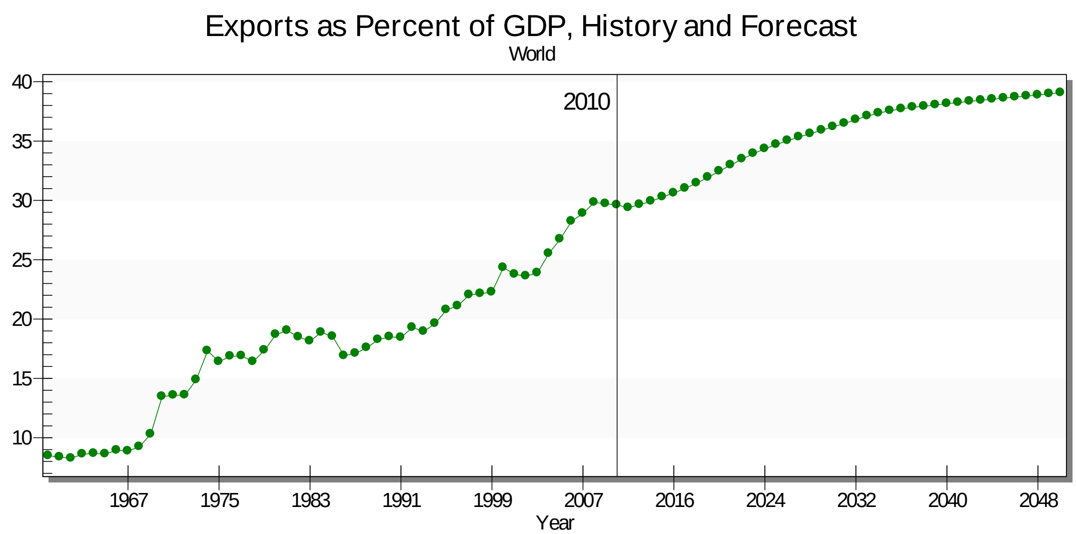

Figure 73: Global Exports as a Percentage of GDP - History and Forecast

To forecast the impact of trade on Kantian Liberalism, I use a measure of imports and exports of goods and services divided by country GDP. This is used in previous approaches to evaluate the impact of Kantian Liberalism (Oneal, Russett, and Berbaum 2003; Russett, Oneal, and Davis 1998; Russett 2001). Historically, the distribution of this has grown from less than 5% of GDP in 1960 to nearly 70% in the early 21st century.

IR Liberalism: Dyadic Kantian Liberal Index

As argued above, Kantian Liberalism has been on the march historically, and we forecast this to continue across time. In the base year, 13 percent of all dyads scored one standard deviation below the mean for the Dyadic Kantian Index indicating that they were very illiberal pairs of states. By 2025, only 2.5 percent of all dyads scored one standard deviation below the mean. By 2050, only 32 out of 16,653 dyads—a mere 0.2%—scored as being less than one standard deviation below the mean. The line-graph below shows the distribution of illiberal dyads in selected years.

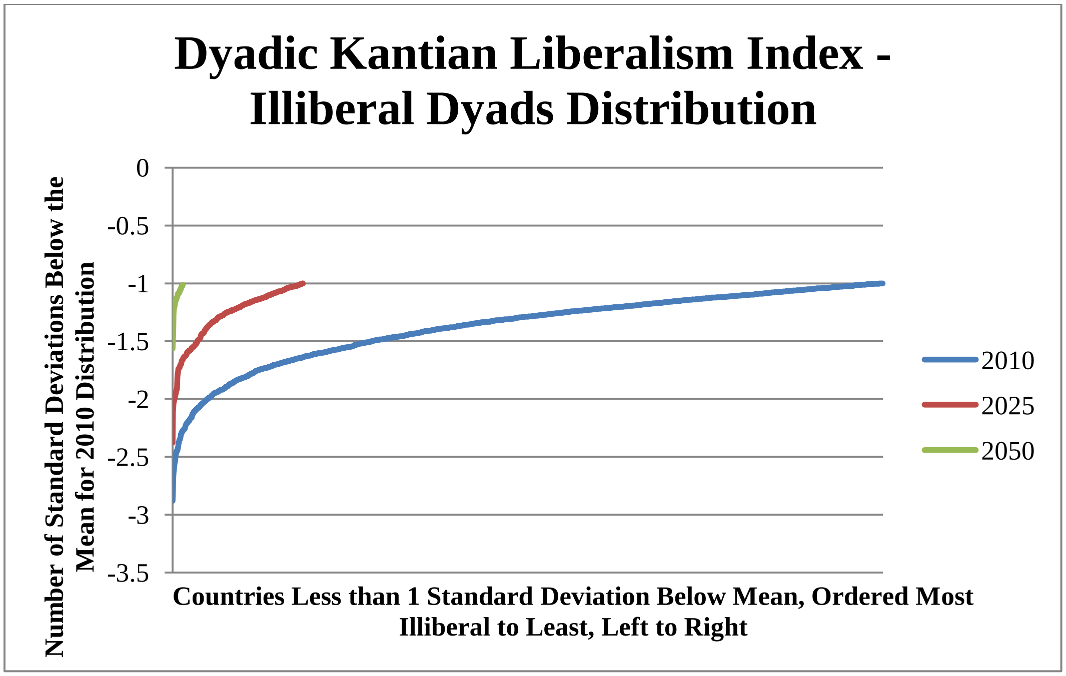

Figure 74: Dyadic Kantian Liberalism - Illiberal Dyads for Selected Years

Aggregating dyadic scores by only averaging dyads that are internal to the group—the line-graph below shows strong growth across time and for World Bank regions. The High Income group begins with the highest level of average dyadic Liberalism (averaging over one standard deviation above the mean) and continues to grow, though with a decreasing rate, to 2050. The next two most liberal groups cluster together generally across the time horizon and are made up of Europe and Central Asia along with Latin America and Caribbean. The four groups that cluster at the bottom—averaging around 0.5 standard deviations below the mean—are East Asia, Sub-Saharan Africa, MENA and South Asia. These groups remain in the bottom four throughout the time-horizon, though growth patterns change. MENA moves from the bottom of the liberal index to the top, spurned largely from forecasts for strong economic growth and democratization. While all other regions grow considerably, even the largest absolute value at the end of the second highest group (Europe and Central Asia) barely achieves the 2010 value for High Income Economies.

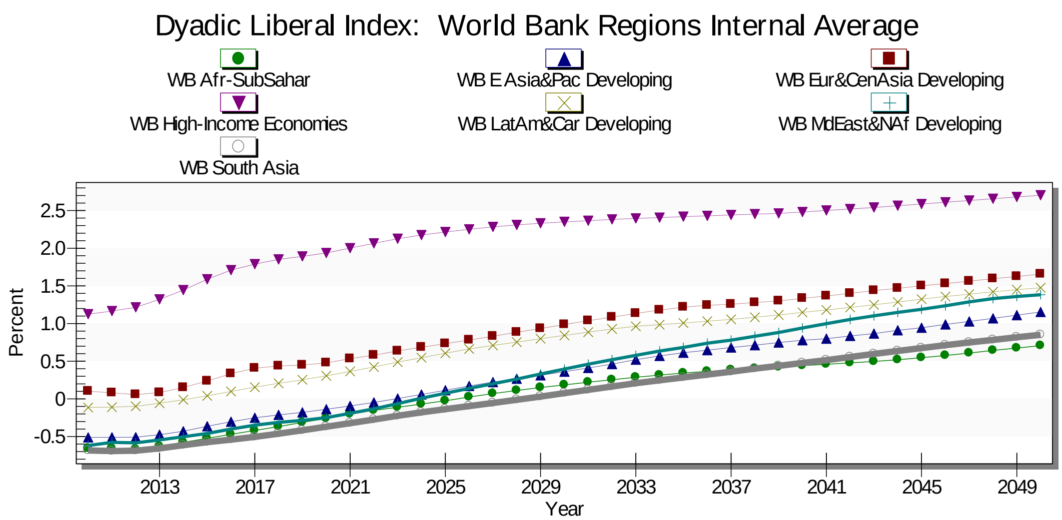

Figure 75: Dyadic Liberal Index: World Bank Regions

The dyads that remain illiberal in 2050—defined here as being more than one standard deviation below the mean in 2010—include the following. Of all of these dyads, only two are politically relevant: Eritrea and Yemen, and Eritrea and Sudan.

Table 8: Most Illiberal Dyads in 2050

Most Illiberal States in 2050: Organized from Most to Least	
Eritrea	Myanmar
Korea North	Myanmar
Eritrea	Korea North
Afghanistan	Myanmar
Myanmar	Tajikistan
Micronesia; Fed. Sts.	Myanmar
Afghanistan	Eritrea
Cameroon	Myanmar
Eritrea	Tajikistan
Central African Republic	Myanmar

Mauritania	Myanmar
Eritrea	Micronesia; Fed. Sts.
Afghanistan	Korea North
Cameroon	Eritrea
Myanmar	Yemen
Myanmar	Rwanda
Korea North	Tajikistan
Myanmar	Uganda
Central African Republic	Eritrea
Chad	Myanmar
Eritrea	Mauritania
Korea North	Micronesia; Fed. Sts.
Myanmar	Sudan
Cameroon	Korea North
Eritrea	Yemen
Eritrea	Rwanda
Gambia	Myanmar
Eritrea	Uganda
Chad	Eritrea
Central African Republic	Korea North
Korea North	Mauritania
Eritrea	Sudan

Cultures of Interaction Index

The Cultures of Interaction Index (CoI Index) is a measure that builds upon standard Kantian Liberal accounts of interdependence—focusing on trade, democracy and global IO memberships—to include variables calculated on a dyad-first basis. It measures affinity between states by measuring levels of trade relative to expected values, IGO membership, treaty signatories and ratifications, alliances, and diplomatic connection.

The IFs system is not able to forecast the CoI Index. This is conceptually because changes in the dyadic measure tend to reflect (apparently) discrete policy choices at this macro, long-term level of analysis instead of other underlying factors, such as income or development. This is obviously an underwhelming component of this project. However the creation of the CoI has put in place the foundation for the eventual forecast of variables that "get at" more complex interdependence and possible cultural influences in dyadic interaction. See the Conclusion for more on the next-steps in this extended project.

Because this variable currently cannot be forecast, it remains one major uncertainty moving forward. To treat this uncertainty, the Base Case of IFs takes the initial value of the CoI Index for countries in 2001 (the most recent data point available) and uses it as a constant throughout the forecast time horizon.

I experimented with extrapolating growth rates from the last 10 years of data from the CoI Index, but this produced results that were unreasonable: some countries with very high CoI scores saw slight declines in these last 10 years. These slight declines in growth made widely understood "good" relationships to appear to deteriorate (for example, the Netherlands and USA experience a massive deterioration in relations over the next four decades using this approach).

The CoI Index thus becomes the main scenario handle in this analysis, used conceptually. In the remaining section of this dissertation I explore output from the model that tends demonstrates that some relationships are forecast to improve while others are forecast to deteriorate. A policy-oriented conclusion is that, to avoid deterioration to the point of conflict, leaders should focus on aligning foreign policy along the lines of the sub-components of the CoI Index. Immediately below is the line graph for World Bank Regions and their CoI Index score.[52]

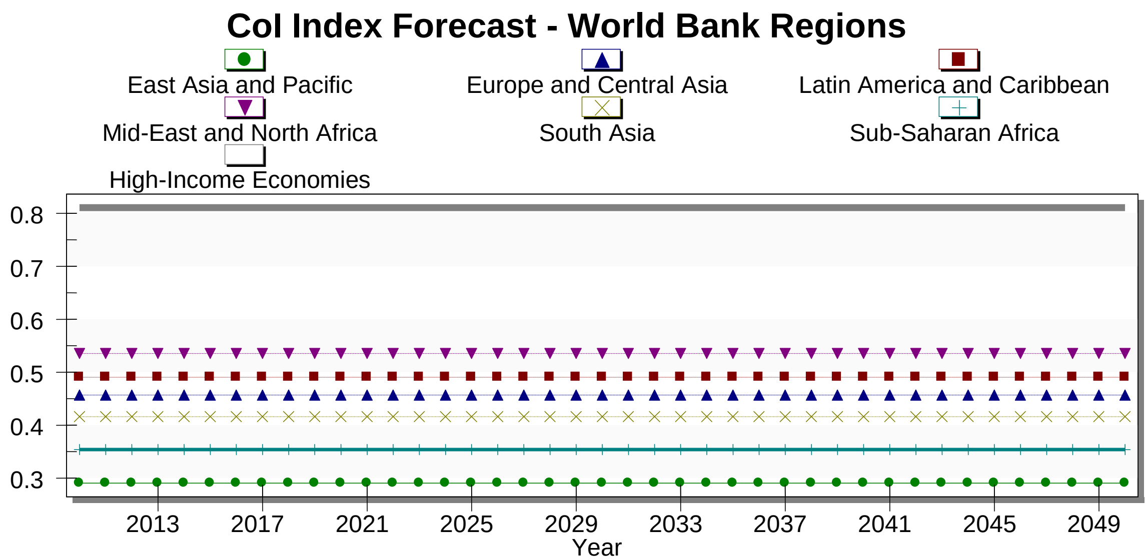

Figure 76: CoI Index for World Bank Regions

The average country CoI with the rest of the world has a strong relationship (0.54 r^2) with the natural log of the historic relative material power measure (the main component of the Realist Index score. This indicates that countries that have higher levels of material power also have both the resources and incentive to project that abroad. The cross-sectional plot demonstrates this, below.

[52] World Bank Groupings were applied using 2011 grouping across time.

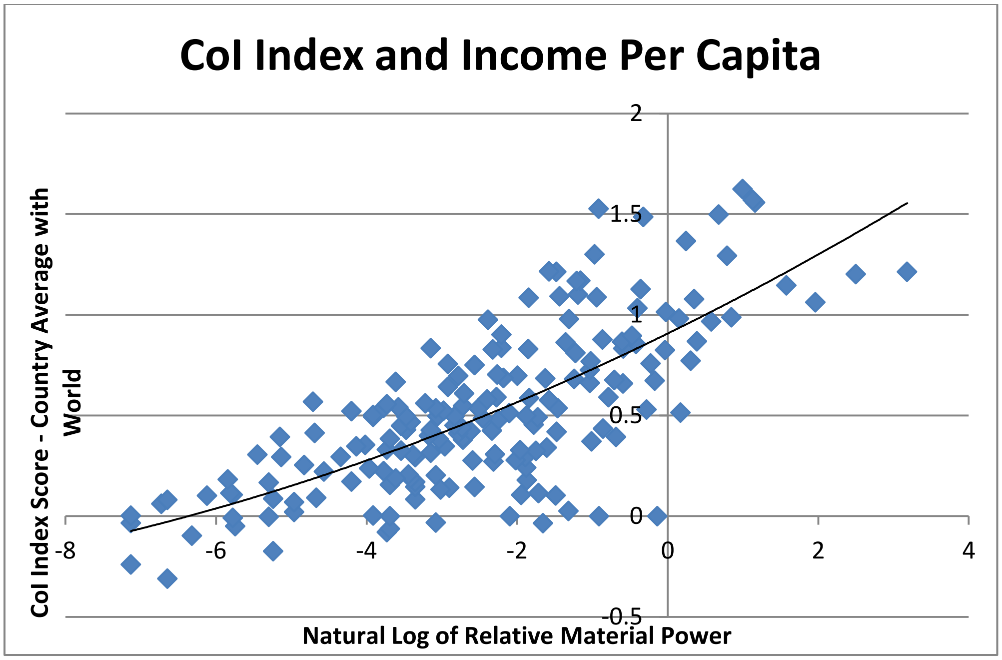

Figure 77: Average CoI Score for Countries and World verses Natural Log of Relative Material Power

This relationship produces an expected value for the overall culture that a country fosters within the IR space. Countries that produce much higher scores relative to what we expect can be thought of as "punching above their weight". The table below highlights the 10 countries that punch most "above their weight" and those that most poorly perform in their average CoI score compared with what we would expect based on their relative material power.[53]

Table 9: Which Countries Punch Above their Weight?

CoI verses Material Power: Who Punches Above their Weight?	
Top 10 Countries	**Worst 10 Countries**
Belgium	Korea North

[53] The regression used to calculate expected values was taken from the following equation:

Expected CoI Average Index Score = (0.0064*(LN Relative Historic Power^2)+(0.1833* LN Relative Historic Power) + 0.9071

The following countries that lack full internationally recognized sovereignty were excluded from this analysis: Taiwan, Hong Kong and Puerto Rico.

Netherlands	Congo, Democratic Republic of
Finland	Myanmar
Sweden	Qatar
Denmark	Afghanistan
France	Somalia
Hungary	Saudi Arabia
Norway	Angola
Bulgaria	Brunei
Austria	Vietnam

If I did treat the CoI with extrapolate growth rates, negative rates would apply to 1,324 dyads. This represents less than 8% of the total dyads in the distribution and indicates that this percentage of dyads experienced deterioration in their CoI score between 1991 and 2001. Samples from dyads that experience negative growth highlight the limits of a pure extrapolative method over more than sixteen thousand samples. Many of the dyads that drop had very high CoI scores and showed stagnation across the last decade of the 20th century, and a very slight decline. This decline over a 40 year time horizon—even if slight—produces large negative scores that are implausible, and skews forecast results.

Integrating IR Theory:

I argued in Chapter 4 that an integrated approach to doing international relations analysis should provide more insight in explaining behavior in the international system than using any theory in isolation. In Chapter 5 I used logistic regressions and large-n data analysis to show that adding up indices representing Realism, Liberalism and Cultures of Interaction produced a better statistical fit to the historic occurrence of international conflict than either of these indices alone, thus giving credence to my claims in Chapter 4. This final section of Chapter 6 shows the final output of this analysis.

The Integrated IR Index score represents endogenously forecast values for the Liberal Index and the Realist Index from 2010 to 2050. It is also initialized with 2001 values of the CoI Index, which are kept constant across time. Changes in the index reflect changes in Realism and Liberalism within the dyad. The entire analysis hinges on the following interaction: is interdependence and culture a more powerful driver of the character of bilateral relations than pressure stemming from material resources over the next 40 years? Which dyads are most likely to see a downward pressure on the quality of their relationship, and how much of an increase in the CoI Index would be needed to off-set this?

Overall, the integrated IR index grows over time. Regional scores for the Integrated IR Index also increase steadily across time. This is shown in the line graph below using World Bank regional grouping scores (the average score of each dyad within the grouping with the rest of the world).[54] This is not un-expected behavior, as these average scores do not measure political relevance. As Realist pressure remains generally stagnant at this level of analysis, the growth in Liberalism helps to drive this forward. Macro-level analysis of this measure belies the possible occurrence of conflict at lower levels of analysis.

[54] This uses 2011 World Bank regional groupings.

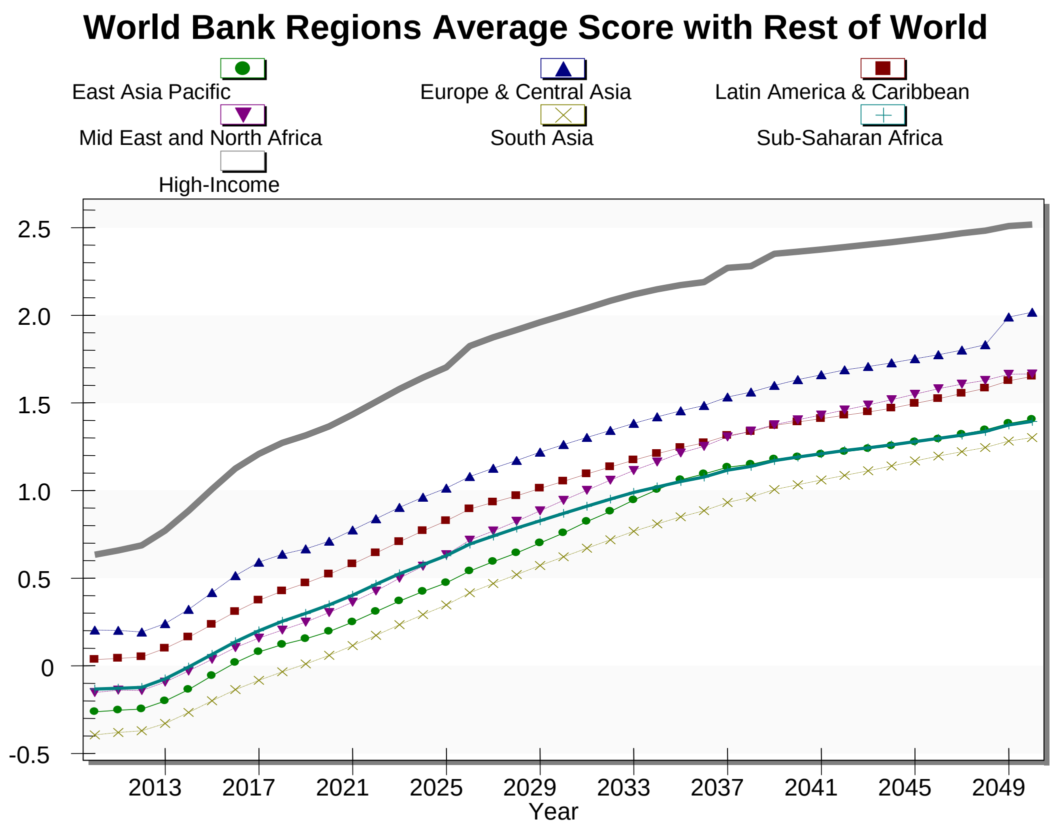

Figure 78: Integrated IR Index for WB Regions

The line graph below shows three time periods and the change in dyadic IR scores. Each point represents a dyad-year score for 2010, 2025 and 2050 sorted from most conflictual (to the left) to most convivial (to the right). The overall trend in international relations is a shift to more cooperative relations, though challenges persist. The dyads on the far left of the plot—those with the most conflictual relations—continue to have very low scores, some nearly five standard deviations below the world average score in 2010 out to 2050. Thus, even though the majority of dyads improve the character of their relations over time, there will still be a handful that—even driven by a generally rosy scenario like the Base Case in IFs—are likely to experience structural pressure on their relationship in a negative direction.

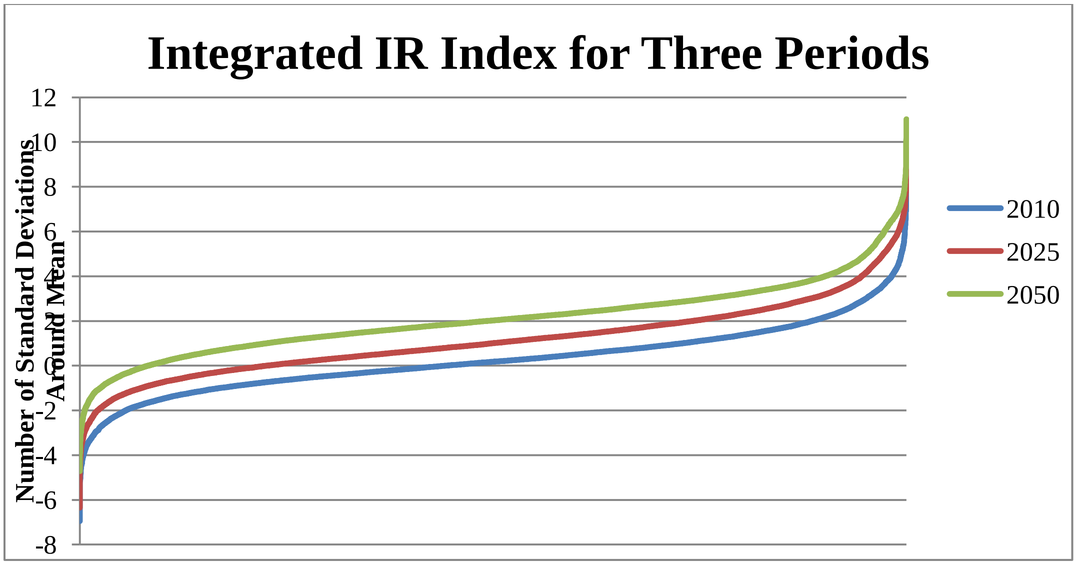

Figure 79: Full Distribution of Integrated IR Theories, 2010, 2025 and 2050

Individual country scores show some states to have generally more strained overall relations than others. The table below shows the dyads with the lowest scores for 2010, 2025 and 2050 for the Integrated IR index that are politically relevant ranked from lowest IR Index score at the top. The pairs of states on this list tend to be illiberal, have poor cultures of interaction and share much material power parity. Moving across time, many of the usual suspects remain with very poor relations. These results are less insightful for policy prescription, but further validation that the approach to modeling is successful.

Table 10: Dyads with Lowest Overall IR Index Score for 2010, 2025 and 2050

Lowest Integrated IR Scores for Politically Relevant Dyads in Select Years					
2010		**2025**		**2050**	
Afghanistan	Uzbekistan	Afghanistan	Uzbekistan	Congo; Democratic Republic of	Sudan
Congo; Democratic	Sudan	Madagascar	Mozambique	Afghanistan	Uzbekistan

Republic of					
Iraq	Syria	Congo; Democratic Republic of	Sudan	Cuba	Haiti
Madagascar	Mozambique	Samoa	Tonga	Sudan	Uganda
Congo; Democratic Republic of	Tanzania	Cuba	Honduras	Congo; Democratic Republic of	Uganda
Eritrea	Ethiopia	Cuba	Haiti	Samoa	Tonga
Eritrea	Sudan	Congo; Democratic Republic of	Uganda	Cameroon	Niger
Ethiopia	Sudan	Congo; Democratic Republic of	Tanzania	Eritrea	Sudan
Iraq	Qatar	Eritrea	Ethiopia	Congo; Democratic Republic of	Tanzania
Uganda	Congo; Democratic Republic of	Syria	Iraq	Ethiopia	Sudan

Other states have overall Integrated IR scores that are extremely high. These states tend to be small and deeply embedded in international political systems through trade and membership in international organizations (and increasingly through improvements in domestic decision-making inclusion). These states, like Luxembourg, Hong Kong and Singapore, also have few enemies, and generally have very low Realist pressure scores. The table below shows the top 5 dyads for each time period as well. Again, these results are less relevant for policy prescription, but an additional validation of the model performance across time.

Table 11: Dyads with Highest Overall IR Index Score for 2010, 2025 and 2050

Highest Integrated IR Index Dyads - Select Years

2010		2025		2050	
Netherlands	Luxembourg	Singapore	Hong Kong	Singapore	Hong Kong
Luxembourg	Hungary	Netherlands	Luxembourg	Luxembourg	Hong Kong
Luxembourg	Finland	Luxembourg	Hong Kong	Netherlands	Luxembourg
Slovak Rep	Luxembourg	Singapore	Luxembourg	Singapore	Luxembourg
Luxembourg	Italy	Luxembourg	Hungary	Russia	Luxembourg

Across the full time horizon not one state experiences a deterioration in their average Integrated IR index score with all other countries between 2010 and 2050. This is caused by the massive increase in Liberalism which offsets any build-up in negative pressure from Realism. However, average country-level Integrated IR scores can be misleading. In many cases one country only experiences deterioration in Realist pressure with only one other country and an improvement in Liberalism more generally with many other politically non-relevant dyads. Because of the mitigating impact of averaging across all dyads, it is useful to also identify those dyads that do experience an overall deterioration in their Integrated IR Index scores between 2010 and 2050. These pairs of states are those where improvements in interdependence do not off-set the deterioration of impacts from Realist pressure.

The table below shows the politically relevant dyads with an overall deterioration in their Integrated IR scores between 2010 and 2050 along with the dyad scores for sub-indices for 2050. The list is small, and is made up of a range of Great Power dyads and non-Great Power dyads. The greatest deterioration comes between Japan and Nigeria, who see their dyadic score drop 0.85 standard deviations in the 40 year time horizon. This is due to the relative decline in Japanese material power and the rise in Nigeria. Japan begins the time horizon with just less than 5% of the world's material resources and ends with 2.3%. Nigeria begins in 2010 with only 0.8% of material power and grows to just under 2%. This shift places both countries on the threshold of Great Power status (with Japan almost losing it, and Nigeria almost gaining it). This, coupled with slow improvements in Liberalism in Nigeria, produce a deteriorated dyadic IR score. The second largest reduction in the IR score is between the US and India, which sees an overall drop in their Integrated IR score of 0.66 standard deviations from 2010 to 2050. This is due to the dramatic convergence between the countries in their Realist index score, and their already relatively high levels of Liberalism. Below I discuss this dyad in more detail. Other dyads on this list experience increases in relative material parity with already high levels of global interdependence (Algeria - Italy and Algeria - Spain), or increases in power parity with low levels of Liberalism (Mauritania - Algeria, Nigeria - Brazil). The reductions in these dyads assume that CoI Index scores remain the same in 2010. Each of these reductions can be ameliorated through an improvement in the CoI in a dyad.

Table 12: Politically Relevant Dyads with Reduction in IR Index Score between 2010 and 2050

		CoI Index	**Realism Index**	**Liberal Index**	**Integrated Index**	**Change to 2050**
		2050	**2050**	**2050**	**2050**	**2010-2050**
Nigeria	Brazil	1.7575	-4.301	0.759	-1.7845	-0.143
USA	India	1.7849	-4.961	0.798	-2.3781	-0.664
Spain	Algeria	1.909	-3.783	1.337	-0.537	-0.165
Italy	Algeria	1.8993	-3.375	1.314	-0.1617	-0.112
Nigeria	Japan	1.6563	-4.494	0.867	-1.9707	-0.85
Mauritania	Algeria	1.7128	-2.5	0.083	-0.7042	-0.272

The evaluative techniques used above help to highlight the relative quality of the model used (results are largely intuitive) as well as some important stylized facts (overall, relations are getting better but a handful remain highly problematic. This is useful, but only scratches the surface of the utility of a tool like the one created in this dissertation project. Each of these indices can be explored for any dyad under any scenario (say, greater BRICs growth, or faster reductions in fertility rates, for example). A full ranging analysis would involve nearly an infinite number of uncertainties to model. Instead of going down this path, the remainder of this chapter assessed various dyads and regions to explore the implications for conflict over the next 40 years.

The three countries of the emerging global high table—China, India and the US—each have dyadic interactions that pose challenges across this time horizon. The line graph below explores this interaction for the US and China using the three sub-indices created in this project along with the composite index. The CoI Index score is stable across time and fixed at the 2010 global mean for this measure. The Liberal Index score begins well below the global mean in 2010, then achieves this by 2030 and advances beyond this to the end of the time horizon. The Realist Index score is quite low, and declines to the middle of the time horizon and then begins to increase, as this is when China passes the US and becomes the global material power leader. The Integrated Index—the measure that performed better than any of the sub-measures combined in my statistical analysis in Chapter 5—shows a relatively flat trend across time. There is a slight increase to 2025, then a slight decline, then a slight increase again.

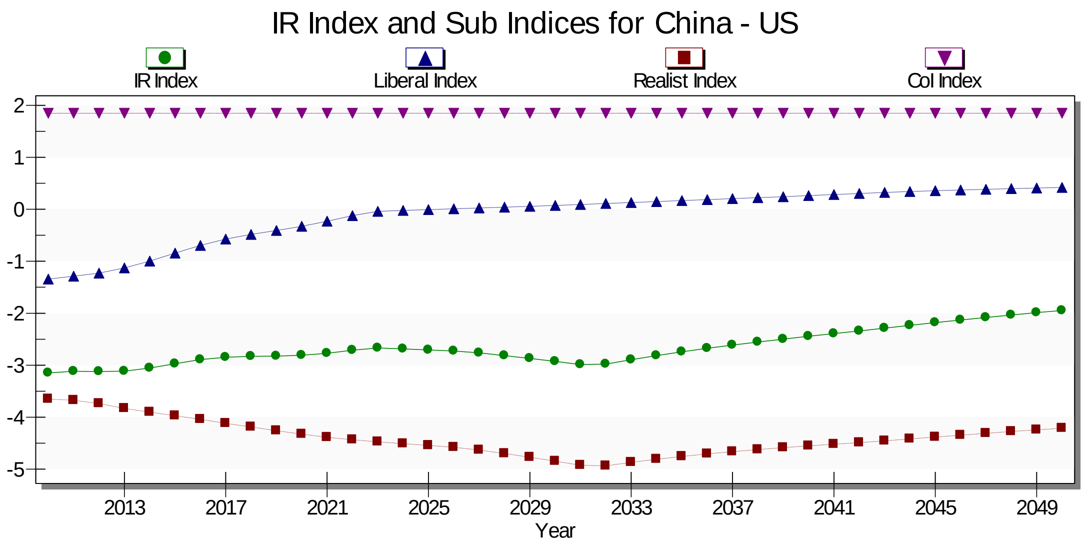

Figure 80: Forecast for China - US for Sub Indices and Overall Index

This lack of massive decline in the Integrated Index between the US and China may seem to be a good thing. Note the overall score in the graph above and compare it with Figure 79 showing the distribution of all dyads across the time horizon. A score ranging between -5 and -3.5 is very low, in fact, and indicates a relationship that could quickly enter into a vicious cycle resulting in heightened tension between the states. This may or may not lead to conflict across time. The policy recommendation for this relationship is to conscientiously work at increasing the culture of interaction between the two states.

A similar story can be told by looking at the line graph relationship between China and India. here we see a similar level of CoI between the dyads across time, a similar Liberal Index increase in the first half of the time horizon but a more stagnant Realist Index score. This leads to an Integrated Index score that is absolutely very low (again, see Figure 79 for an idea of where it fits in the overall distribution) that only slightly increases across time. The policy recommendation for this dyad is to also find ways to increase and improve the culture of interaction in order to avoid a protracted conflict.

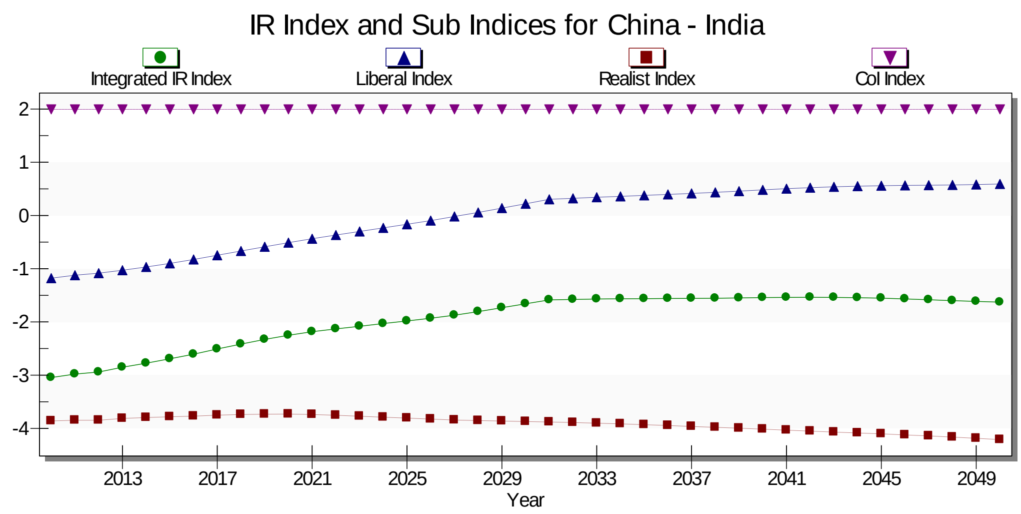

Figure 81: Forecast for China - India for Sub Indices and Overall Index

The simple insight is that, in dyads where there are high levels of Realist pressure, both Liberalism and CoI play an instrumental part in improving the overall relationship. Two states that have high level of Realist pressure but more convivial relations are the US and Japan. Their relationship is shown in the line graph below. Here, there is a much higher CoI Index score that brings the overall Integrated IR index score up to a range that is much closer to the global mean across time, and more likely to produce a relationship that is positive.

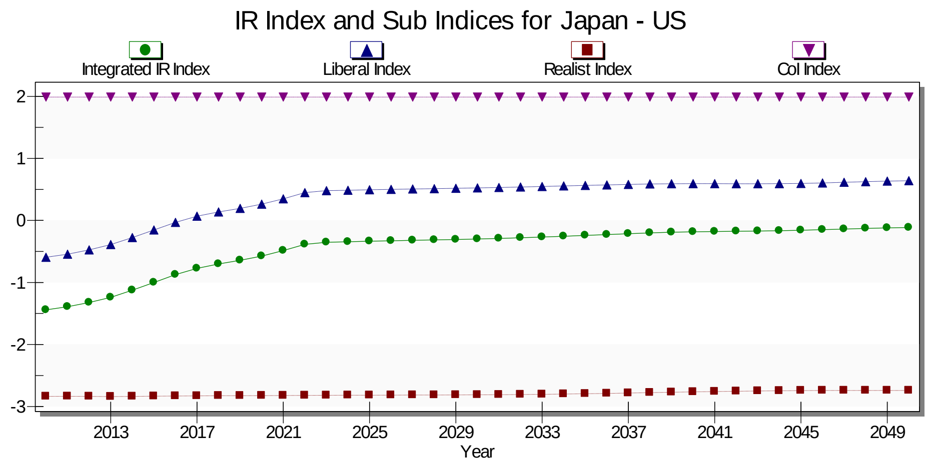

Figure 82: Forecast for Japan - US for Sub Indices and Overall Index

While the China - US and China - India score is dangerously low (and remains fairly low across the time horizon), the India - US score experiences a deterioration across the forecast horizon (as noted above in Table 12). This reduction does not occur immediately, but takes place after the first third of the time horizon as India's material power is forecast to grow considerably. The line-graph below demonstrates this dynamic. The policy take-away for this relationship is that, while the dyad enjoys a high CoI Index score in the base year and a rising Liberal Index score across the time horizon, care must be taken to further bring policies in line and orchestrate a culture of interaction that continues to promote cooperation and understanding.

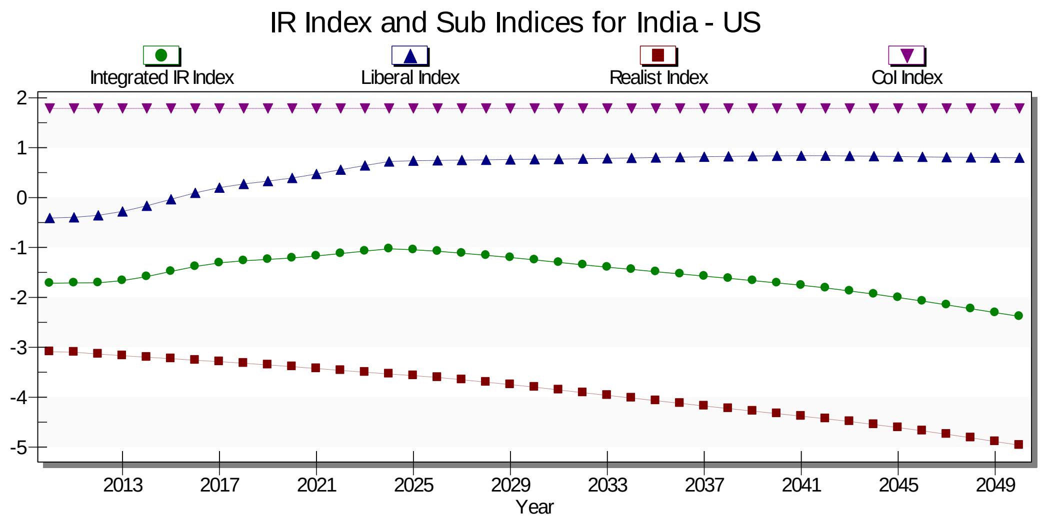

Figure 83: Forecast for India - US for Sub Indices and Overall Index

The previous analysis explored the three major players at the global High Table over the next forty years. It argued that much work remained to be done to bring policies in line in order to avoid a potential conflict (be that a direct conflict, or a proxy conflict ala the Cold War). The two dyads most in danger were the China - India and China - US with the India - US dyad also remaining vulnerable to a future conflict if the culture of interaction was not improved.

This analysis now moves to regional dynamics by exploring regional dynamics related to the Integrated IR Index. The first is the Middle-East. The line-graph below shows the relationships between Iran and selected Middle-East countries. It shows a similar pattern of growth seen in many areas, indicating that there is the prospect for improved relations across time, though problems are likely to persist. The lowest score in this graph is in the relationship between Iran and Saudi Arabia, a well-understood dynamic in regional power dynamics, though this does increase considerably in the first twenty years due to an increase in dyadic Liberalism. The highest score is with Lebanon, a reflection of close ties (through Hezbollah, for example) that only grows more strongly across time. Iran and Iraq have strained relations, but these are forecast to improve with time as well.

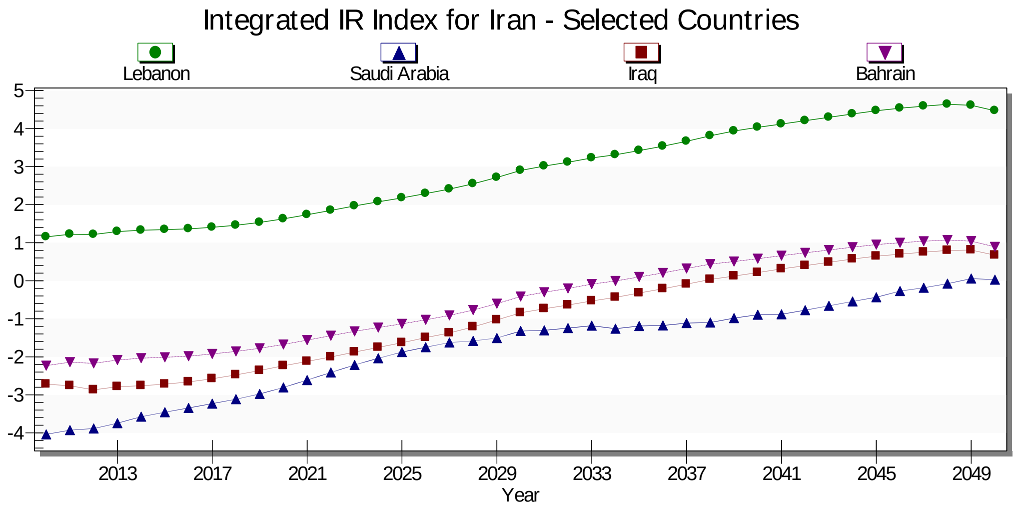

Figure 84: Integrated IR Index for Iran - Selected Countries

Another obvious country to evaluate using this approach is Israel and her relationship with the broader Middle-East. The line-graph below does this for selected countries. It shows that Israel has very poor relations with Syria, Lebanon and Egypt, though it shows improved relations with Iran and Iraq, both because Israel and these countries are not considered to be politically relevant dyads due to their lack of contiguity and Great Power status. This is a short-coming of this approach to analysis, and is slated to be improved with follow-up work. See the Conclusion for more information. For Israel's long-term perspective, the very low relations with Egypt, Syria and Lebanon are particularly concerning. While Liberalism increases in these dyads, it is barely enough to offset very low CoI Index scores and changing Realism. While policy prescription in this context is particularly complicated in light of the dynamics of the Mid-East conflict, finding more areas of alignment (certainly around the issue of Palestine) should continue to be at the heart of foreign policy.

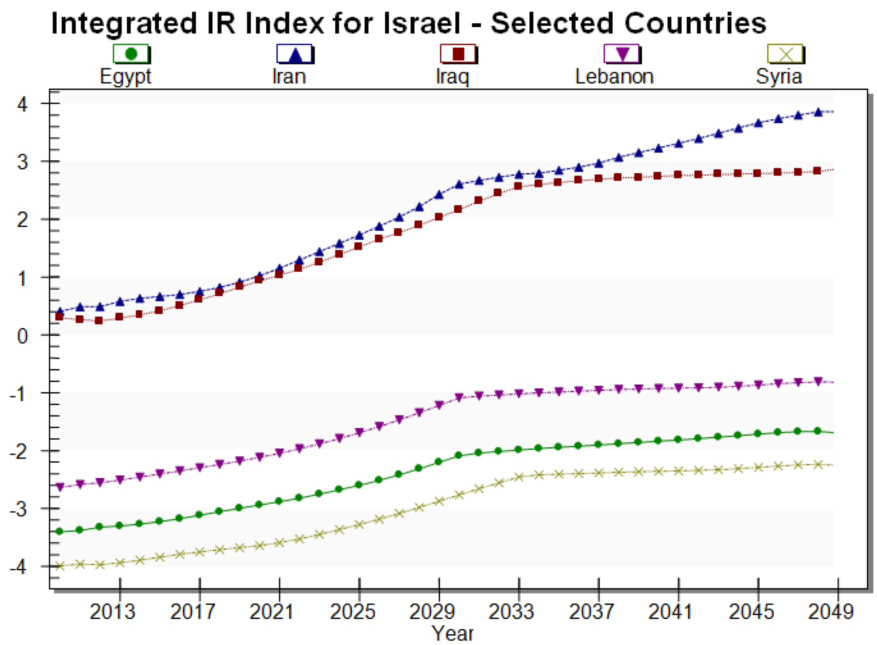

Figure 85: Integrated IR Index for Israel - Select Countries

Central Asia experiences a rapid power transition between Turkmenistan and her neighbors (identified in the section on the Base Case of Realism, above). This leads to some Integrated IR Index scores that reduce in the Base Case. The line-graph below documents key relationships for Kazakhstan—the current material power leader in the region—and select neighbors. Even with strong growth in Liberalism through gas exports in Turkmenistan, this relationship drops in the middle of the time horizon, though it does not drop to the nadir of the relationship between Kazakhstan and Turkmenistan. This is one finding of this project that may require further investigation and is clearly policy relevant.

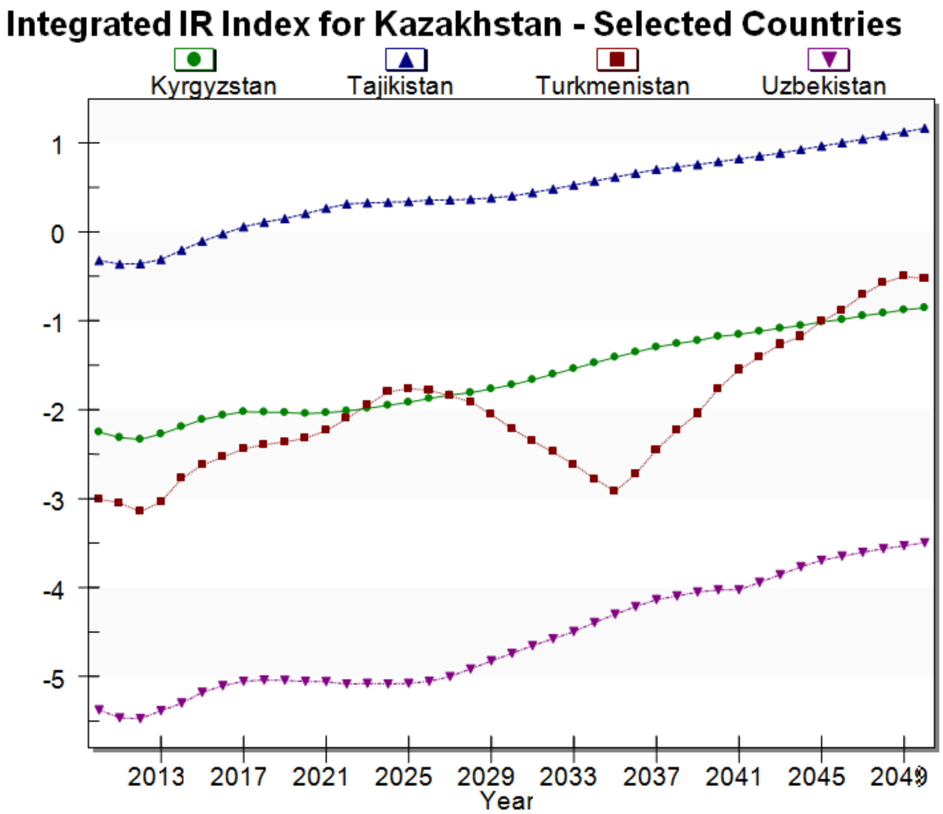

Figure 86: Integrated IR Index for Kazakhstan - Selected Countries

Moving to South Asia, India has relations with its neighbors that are generally strained. The initial condition for the Integrated IR Index shows India to have generally poor relations with China and Myanmar, and slightly better relations with many of its other neighbors. That said, these improved relations are still generally at absolutely poor levels (generally below one standard deviation below the mean, except for Sri Lanka). Surprisingly, the relationship between India and Pakistan is shown to be of higher quality than many would expect (still, more than 1.5 standard deviations below the mean). This is largely due to their CoI Index starting point, which reflects concerted efforts on the parts of both countries to retain diplomatic connection in the face of extended hostilities.

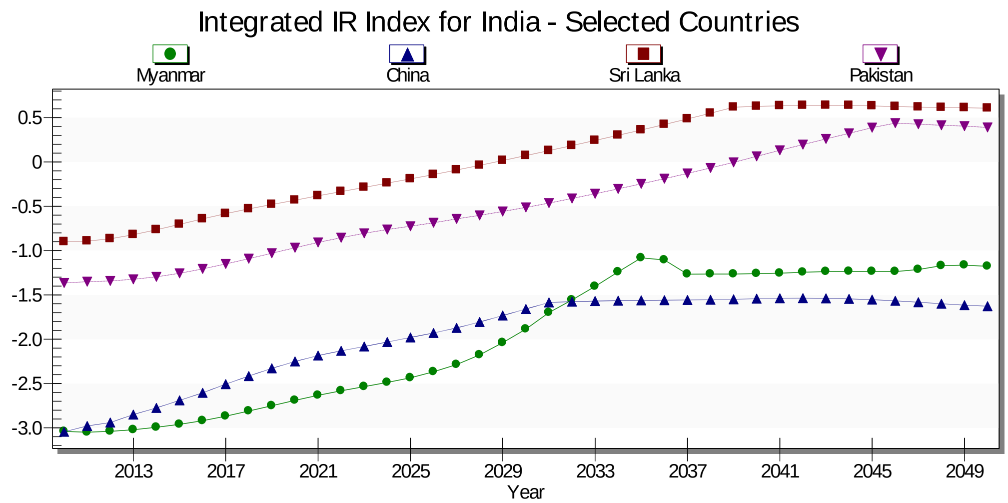

Figure 88: Integrated IR Index for India - Selected Countries

Moving further South East, the line-graph below tracks the relationship between Indonesia and some of her neighbors. The two countries with the lowest relations by the Integrated IR Index approach are Australia and Vietnam. Both are considered to be politically relevant and have similar (though not as much) relative power as Indonesia. Also, both have experienced strained relations. Australia and Indonesia have had conflict surrounding terrorism (the Bali bombing, for example) and domestic policy decisions (the treatment of succession by East Timor). The strongest relationship is with Singapore due to high CoI Index scores and Liberalism.

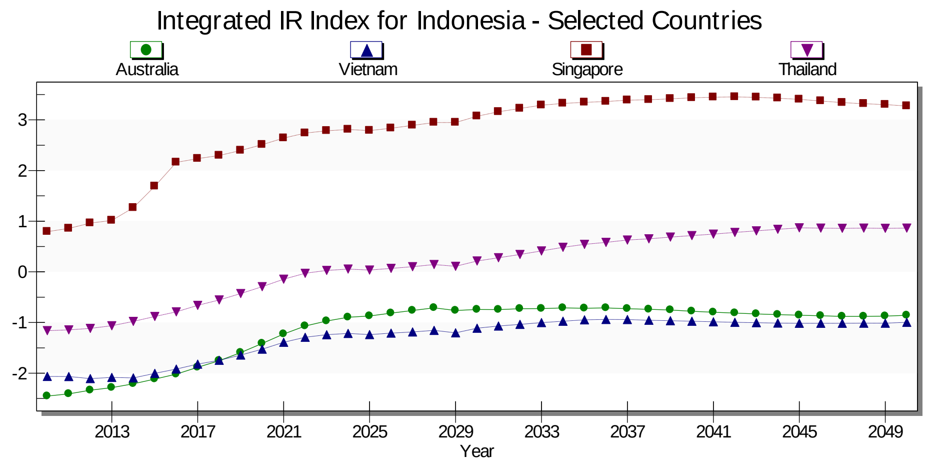

Figure 89: Integrated IR Index for Indonesia - Selected Countries

China's relations with neighbors are generally poor due to low levels of Liberalism and CoI scores. The line-graph below shows this. It demonstrates that relations generally improve, except for the US early in the time horizon and India late in the time horizon. Even by 2050, though, none of the dyads in the graph below reach the global mean in 2010 (though Russia comes close).

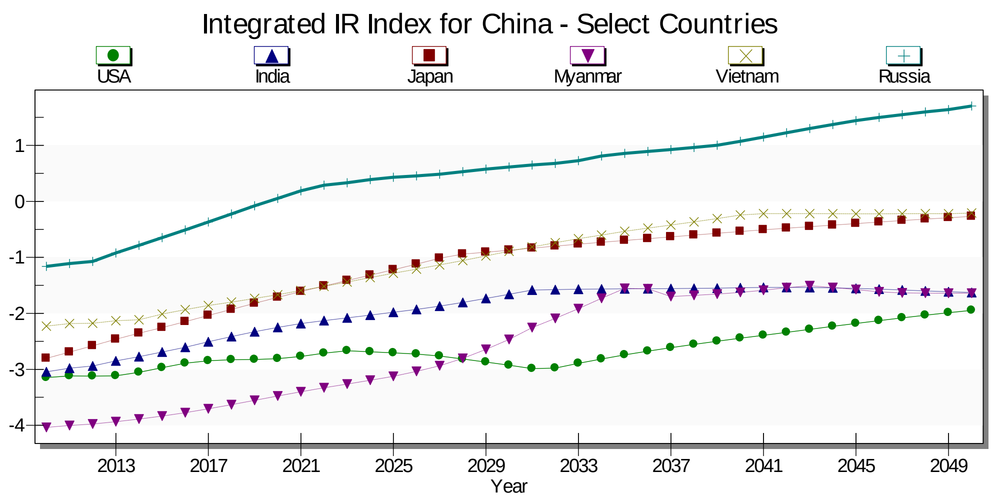

Figure 90: Integrated IR Index for China - Selected Countries

Traveling across the Pacific to South America, Brazil generally has better relations with her neighbors than many of the countries explored above. The line-graph above shows Brazil with fairly deteriorated relationships with both Colombia and Venezuela, but these are both less than two standard deviations below the mean (see China above for a comparison) and increase rapidly. Other key partnership in that neighborhood also experience extended growth.

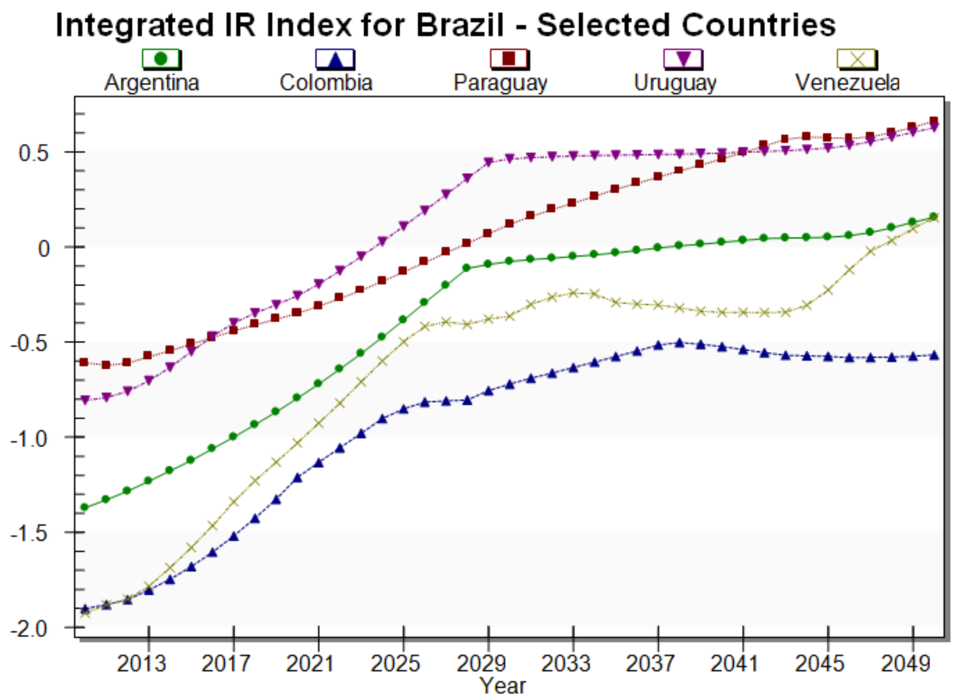

Figure 91: Integrated IR Indices for Brazil - Selected Countries

Moving again across the ocean to the East, Nigeria enjoys positive relations with the other great powers of Africa (Egypt, Ethiopia and South Africa) but more deteriorated relationships with their immediate neighbors. That said, the absolute value of the lowest score (1.5 standard deviations below the mean in 2010 for Cameroon) is the quality of relationship expected between China and Vietnam in 40 years (see Figure 89). The bubble demonstrated in the line-graph below is the impact of peak oil on Nigerian Liberalism (major declines in overall exports), though relations still do not fall to the level of 2010.

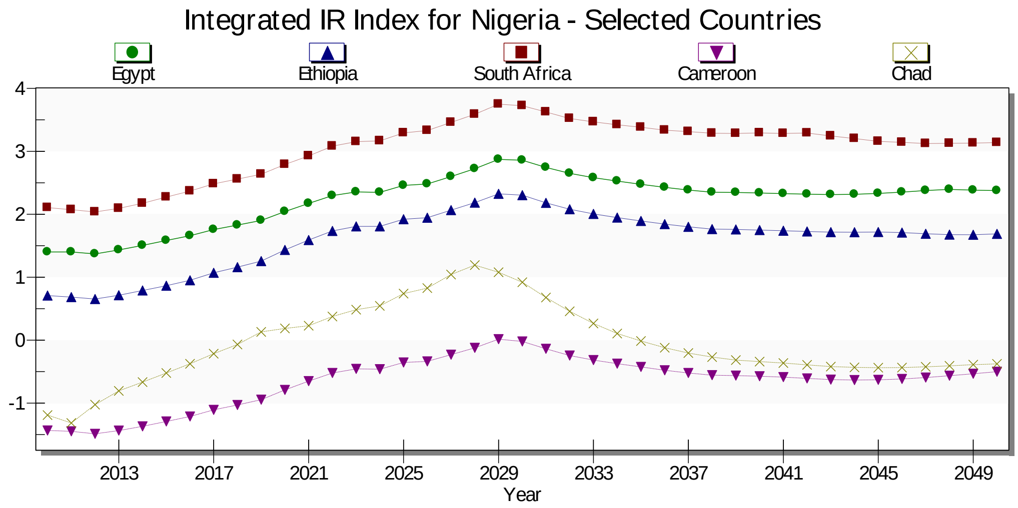

Figure 92: Integrated IR Index for Nigeria - Select Countries

Conclusion

This chapter represents the culmination of the work of this project in building a model that forecasts IR theory to 2050. The final section—producing analysis of dyadic behavior, regional behavior and Great Power behavior—has demonstrated some of the capabilities of this tool. While demonstrating capabilities, it has just scratched the surface in terms of their exhaustion. Further analysis on the IR indices needs to be done taking into consideration scenarios around the Base Case of IFs, further and more nuanced treatment of regional great powers and the forecast of the CoI endogenous to the IFs system.

7. Extending the Analysis: Analyzing Structural Change Related to Dyadic Conflict to 2050

Introduction

Modeling IR theory provides a starting-point for thinking systematically about how dyadic relations are forecast to change across time. However, exploring Realist, Liberal and cultural drivers also likely misses important structural shifts and pressures within the international system. This chapter moves beyond a singular focus on IR and considers other drivers of change in dyadic relations across time.

The Base Case forecast described in Chapter 6 is generally positive: even with the stock of cultural interaction remaining at 2010 values, interdependence from Liberalism continues to grow and outstrips negative pressures from Realism. However, this positive development could be derailed by shifts in resource availability and other structural transitions in the international system. The deeper drivers of the character of state behavior explored in this chapter are the following: dwindling global production of fossil fuel, changes in fresh water resource availability and the impact of state fragility.

Conceptually, the Deep Drivers of state behavior operate directly on the IR indices explored in Chapter 6 as well as directly on the character of dyadic interaction first introduced in Chapter 1. The diagram below illustrates this. The forecast in Chapter 6 already considered the three left-most arrows in this diagram, as the impacts of future structural changes are endogenized within the IFs system. However, the long arrow showing the connection between the Deep Drivers and the Character of Dyadic Interaction was not represented in Chapter 6.

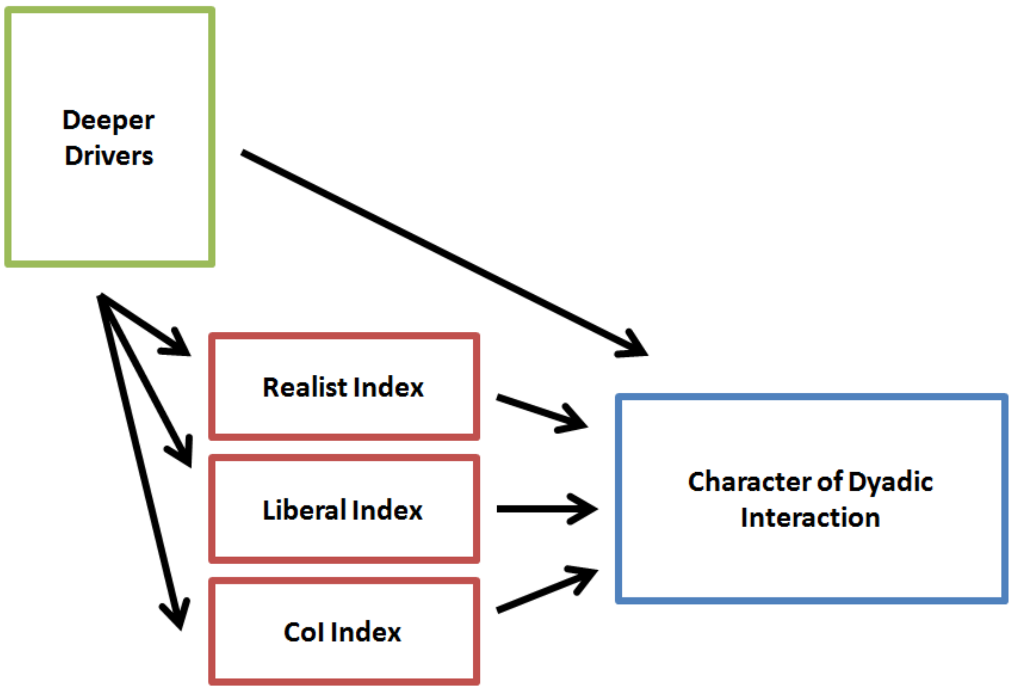

Figure 93: Conceptual Relationship between Deep Drivers of State Behavior, IR Indices and Character of State Behavior

The most interesting question answered by this type of analysis is whether structural changes in the international system—coupled with pressures arising from changes in the distribution of relative material power—have the real possibility of derailing the overall gains in stocks of interdependence and cooperative culture. This chapter does not make any definitive conclusions to that end. However, this project has put in place the foundational pieces that can eventually lead to a more thorough evaluation of that question.

I conclude that pressures from Water Resources are likely to increase for specific dyads across the Middle East and Central Asia over the next four decades. Disruptive pressure arising from State Fragility is likely to decline across all politically relevant dyads, though specific pairs of states will continue to experience poor relations because of this driver of conflict. Finally, pressure arising from Fossil Fuel resources is likely to increase for some Great Powers and states with very large overall reserves.

Fresh Water Resources

Fresh water resources are a fundamental component of human development. As these water resources become increasingly stressed by overuse, aquifers will be drawn down, and countries that share river basins will increasingly see water resources cloud foreign policy decision-making. It is the goal of this section to highlight which dyads are most likely to experience these pressures.

Water resource data is initialized in the IFs model using AQUASTAT data (FAO AQUASTAT 2012). Water use per capita—the distal driver of water use in IFs—is calculated using an equation that considers both agricultural production (as a proxy for the amount of irrigated land) and the overall size of the population. Water use per capita is multiplied by overall population to calculate overall water use. This is divided by the net amount of freshwater entering a country in a given year.

If countries use up to 20 percent of the net freshwater in a given year they are considered to be water stressed (United Nations Environment Programme 2007). The largest regional use of fresh water as a percentage of renewable resources occurs in Northern Africa, where 2010 values show that nearly 80 percent of freshwater reserves are being used on an annual basis. This number grows beyond 100 percent over the coming three decades, indicating that water use in this region will begin drawing down aquifers, that fresh water resources will be imported or that desalination processes will be used to produce the resource. The second highest fresh water use as a percent of renewable resources is the Middle East. Certain countries (such as Kuwait) currently use well above their annual freshwater reserves and actively import water or produce freshwater through desalination.

The two maps below trace water stress levels for the 183 countries modeled in IFs for 2010 and 2050. First, in 2010, water stress is largely measured in the Middle East and North Africa, with notable additions in North America, Europe, East Asia and Southern Africa.

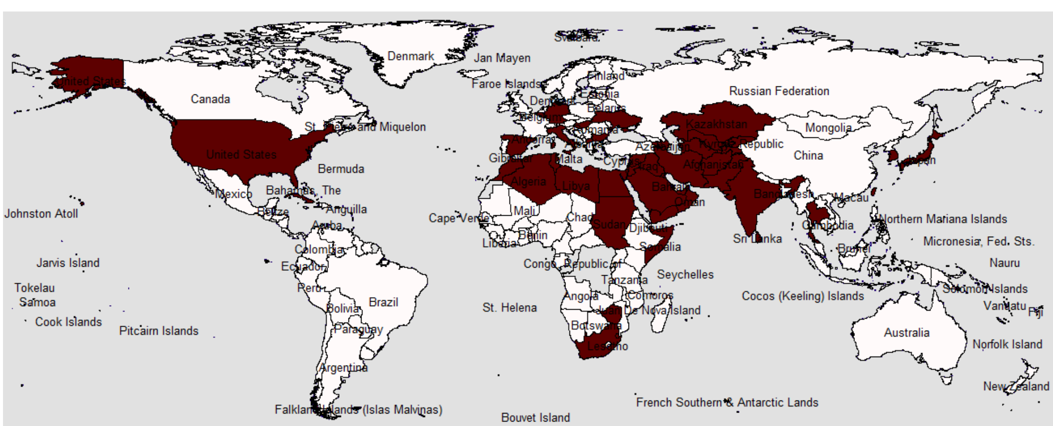

Figure 94: States Experiencing Water Stress – 2010

By 2050, water stress levels have expanded considerably. This Base Case forecast has water stress levels stretching from the Western Sahara to Japan. Countries that share river basins and experience water stress are more likely to consider water resource issues in foreign policy decision-making. High levels of up-stream water use (such as in the Colorado River in the USA) have negative implications on down-stream water availability and pollution levels. By 2050, 56 countries experience water stress. See Appendix 6 for a list of these countries with the percentage of renewable water being used.

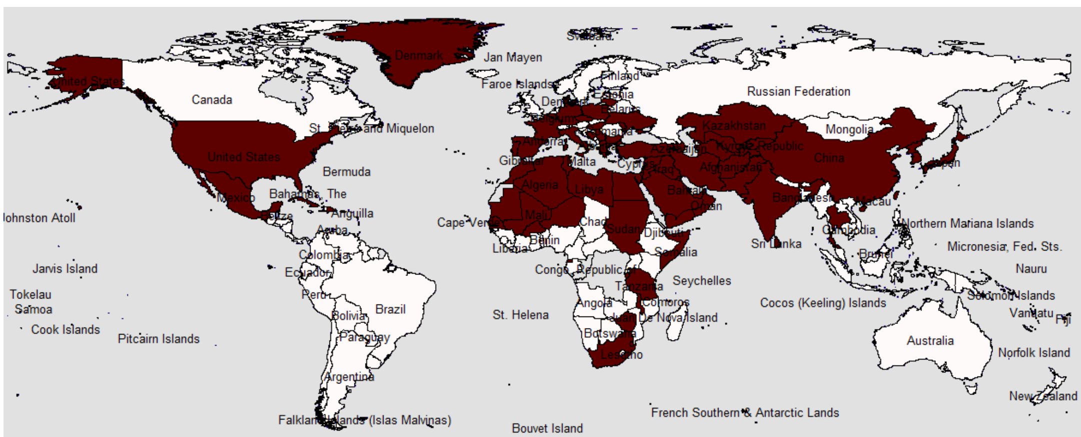

Figure 95: States Experiencing Water Stress 2050

To measure the Dyadic Realist Index score for water resources, the first algorithmic component was a measure of whether the two parties shared a river basin. Shared river basin data was taken from the work of researchers at Peace Research Institute of Oslo (Brochmann and Gleditsch 2006; Furlong, Petter Gleditsch, and Hegre 2006). Next, the IFs model measured the shared level of water stress, across the dyad. If the level was above 20 percent, the model took that to be the lowest threshold for identifying dyadic pressure related to water. In 2010 it took the upper bound of the threshold to be the dyad with the highest level of water stress. The global average Dyadic Realist Index score for water shows an absolute decline across time. This corresponds with increased levels of fresh water use as a percentage of renewable water.

Taking country average scores with the world for the Dyadic Index for water resources demonstrates which states are likely to see water resources play an increasing role in their foreign policy making across relationships. Those countries with a 0.1 standard deviation deterioration in their relationship or more are listed in the table below ordered from greatest absolute change to least. Notably, much of this increase in water stress occurs in Central Asia.

Table 13: Absolute Change and Level in 2050 of Water Stress for Average Dyadic Index Scores

	Absolute Change from 2010 to 2050	**Absolute Value in 2050**
Afghanistan	-0.309	-0.539
Iran	-0.304	-0.582
Sudan	-0.25	-0.511
Iraq	-0.204	-0.739
Pakistan	-0.175	-0.227
Tajikistan	-0.161	-0.376
Turkey	-0.148	-0.292
China	-0.142	-0.193
Turkmenistan	-0.137	-0.429
Syria	-0.127	-0.463
Kyrgyzstan	-0.123	-0.277
Kazakhstan	-0.11	-0.244
Uzbekistan	-0.1	-0.54

The table above provides an overview of the importance of relative water resources on a country basis. Moving down to a deeper level of granularity highlights specific relationships that are likely to experience increased pressures arrising from water resources. These dyads tend to be in areas that are less developed and include many pairs of states where relationships are already tense. The 10 greatest overall deteriorations in the dyadic measure of pressure occurs in the following pairs of states:

Table 14: Top 10 Dyads with Deteriorated Scores for Water Pressure

Top 10 Dyads with Deteriorated Scores for Water Pressure	
Afghanistan	Tajikistan
Iran	Iraq
Afghanistan	Pakistan
Afghanistan	Iran
Kazakhstan	Turkmenistan
Kyrgyzstan	Tajikistan
Iraq	Syria
Afghanistan	Turkmenistan
Iran	Pakistan
Iraq	Turkey

Using the same logic as I tested in Chapter 5, I argue that measuring pressure from water useage but not considering any other theoretical driver of the character of dyadic interaction is misleading. Water stress between highly Liberal dyads in Europe is unlikely to lead to serious conflict; water stress between Syria and Israel is likely exaserbated by their character of interaction. I therefore take the dyadic water stress score and add it to the Integrated IR Index score. The table below highlights dyads with the lowest overall scores for the Integrated IR Index and Water Stress in 2025 and 2050.

Table 15: Worst Dyadic Scores for Water plus Integrated IR Index in Selected Years

Worst Dyadic Scores for Water plus Integrated IR Index in Selected Years			
2025		2050	
Afghanistan	Uzbekistan	Afghanistan	Uzbekistan
Israel	Syria	Afghanistan	Tajikistan
Libya	Niger	Tajikistan	Uzbekistan
Oman	Yemen	Israel	Syria
Tajikistan	Uzbekistan	Egypt	Sudan
Chad	Libya	Turkmenistan	Uzbekistan
Egypt	Israel	Iraq	Syria
Jordan	Syria	Kyrgyzstan	Tajikistan
Turkmenistan	Uzbekistan	Egypt	Israel
Egypt	Sudan	Kazakhstan	Turkmenistan

These dyads are concentrated in the Middle East, Central Asia and North-West Africa. Many of these dyads have a very poor character of interaction already which is likely to be exaserbated over time, such as Isreal and Syria or Egypt and Israel. Other dyads are not on most foreign policy radars, such as Central Asia which is likely to experience extended pressure from increased used of fresh water from a large agriculture sector. This shift, coupled with a large regional transition in material power resources (the rise of Turkmenistan, as discussed in Chapter 6) could lead to a situation where changes made to the Amu River could drive concerns regarding the Aral Sea bringing various groups into a conflictual situation.

Specific dyads are likley to experience deterioration in their Integrated IR Index coupled with water stress, but this is not the case for the majority of dyads across time. The line-graph below demonstrates this by taking all dyad scores for 2010, 2025 and 2050 and exploring their distribution when sorted from worst to best scores (left to right). The overall trend is a positive shift up in relationships across these time horizons for well over 95% of dyads. However, as indicates in the small number of dyads with very poor scores to the far left, even in 2050 dyads will remain with overall IR indices coupled with water stress that are quite poor. The overall shift in imporvement across dyads does, however, lend credence to the idea that water stress is unlikely to undermine increases in overall interdependence and improvements to the overall stock of culture in the international system.

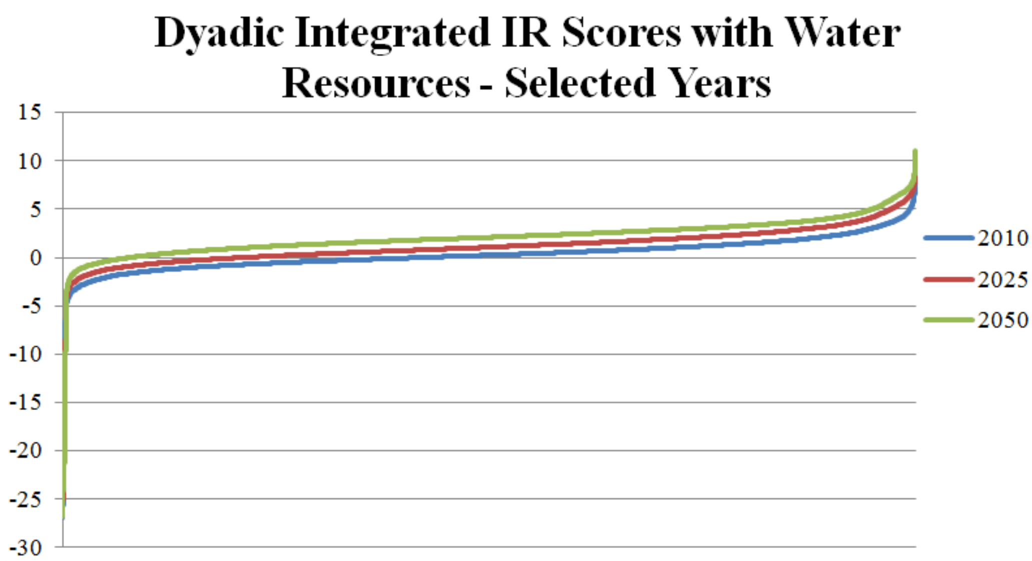

Figure 96: Dyadic Integrated IR Scores with Water Resources - Selected Years

State Fragility

Domestic instability in one country can lead to conflict across countries for one of two reasons. First, there are wars of distraction, which occur when the country experiencing domestic instability attempts to attack their neighbor to unify the country around a common enemy (that is not the domestic power structure). An example of this kind of conflict occurred between Iraq and Iran in the 1980s when Saddam Hussein attacked his neighbor, in part, to unify is fractured country.

The second way that state fragility can lead to international conflict occurs when the more stable neighbor state intervenes in the more unstable neighbor to produce stability. Take, for example, the various incursions into Somalia from her neighbors in recent years. Kenya recently engaged in bombing exercises, Ethiopia sent troops, etc. It is not just neighbor states who engage in this type of behavior. Great Powers are also prone to intervene in failing states in order to produce stability to protect interests, resources and promote international norms. See, for example, the recent intervention in Libya, condoned and actuated by Great Powers.

There exist two general approaches to measuring domestic instability. The first is a probabilistic approach that fits the historic occurrence of instability (be that civil war, abrupt regime change, genocide or revolution) to a statistical model. The most notable example of this approach to measuring the occurrence of conflict is the Political Instability Task Force (previously the State Failure Task Force). They found that a simple probabilistic model of the occurrence of conflict could be made with four driving variables: neighborhood effects, levels of international trade, infant mortality and degree of regime anocracy.

The second approach to measuring domestic instability does not find the best fit statistically to the historic occurrence of domestic conflict. Instead, it takes theoretically salient categories and uses them to create an index measure of how unstable a country is. These categories typically include a measure of economic performance, demographic constraints, government character and the historic occurrence of conflict.

Both probabilistic and index measures of domestic instability are useful for exploring the future of domestic conflict. Probabilistic measures tend to emphasize a handful of countries being highly prone to the occurrence of conflict, as demonstrated in the line-graph below in the blue line. Index measures of domestic conflict, on the other hand, tend to see domestic instability as being a characteristic of governance that changes at different levels of development. This can be seen below in the linear distribution of the George Mason index of state fragility below, the red line.

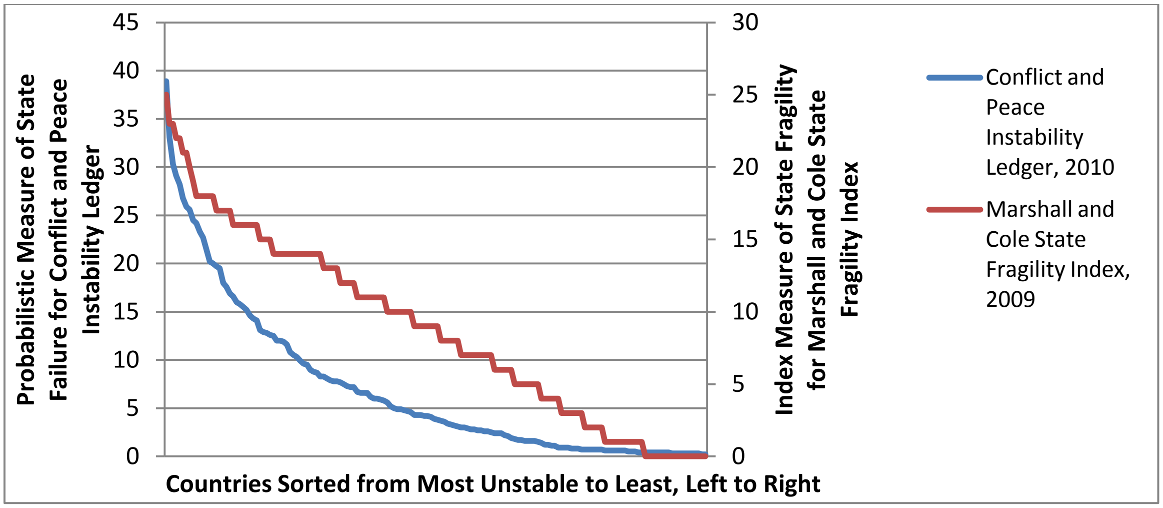

Figure 97: Index verses Probabilistic Measures - State Fragility

It may seem, *prima facie*, that the probabilistic measure of conflict would be a better determinant of the future occurrence of conflict. This has not proven to be the case. For example, see the table below which shows the country ranking for the Maryland Conflict and Peace Instability Ledger (a probabilistic measure) (Hewitt, Wilkenfeld, and Gurr 2010) and the George Mason State Fragility Index (an index measure) (M. Marshall and Cole 2009). In comparing the rankings of five Arab countries that experienced domestic instability in 2011, the measure that performs better consistently is from George Mason based on their country ranking. George Mason ranks all five countries below as being more unstable than the Maryland Conflict and Peace Instability Ledger, even though the later measure is based on a statistical model fit to the historic occurrence of conflict.

Table 16: Ranking Arab Spring Countries by Probabilistic and Index Approaches

Ranking of Select Arab Spring Countries for Two Measures of Domestic Instability: Higher Number More Unstable		
	George Mason State Fragility Index, 2009	**Maryland Conflict and Peace Instability Ledger, 2010**
Yemen, Republic of	27	37
Egypt, Arab Republic of	51	63
Syrian Arab Republic	80	117
Libya	95	115
Bahrain	117	132

This is likely to be a product of the (apparently) discrete nature of the occurrence of conflict. An incredibly small percentage of total possible dyad-years or country-years ever experience conflict (either domestically or internationally). Those that do may cluster around a series of events that have similar driving variables (such as the extreme democratic deficit experienced throughout the Arab world in 2011 coupled with cheap and widely distributed technology).

For this reason I use the Government Risk Index in the IFs system to operationalize the Dyadic Realist Index related to State Fragility. The Government Risk Index is constructed using the same logic used in the construction of the George Mason State Fragility Index in that it identifies a series of conceptually relevant categories of variables related to domestic instability and operationalizes these categories. The table below outlines the sub-components and categories of the Government Risk Index.

Table 17: Components of IFs Government Risk Index

Components of the Government Risk Index in IFs		
Conceptual Category	**Operationalized Variable**	**Description of Variable and Initialization Source**
Governance	**Corruption**	Perceived levels of corruption in country initialized with Transparency International data
	Effectiveness	Measure of Governance Effectiveness initialized with World Bank Governance Matters data.
	Democracy	Measure of regime type: either more autocratic or more democratic initialized with Polity Project data.
	Freedom	Measure of economic freedom within a country initialized with Fraser Institute data.
Security	**Instability**	Aggregate measure taken from Major Episodes of Political Violence
	Internal War	Aggregate measure taken from Major Episodes of Political Violence
Economy	**Poverty**	The number of people living on less than 1.25 USD per day, initialized with World Bank data.
	Inequality	The distribution of income in a country, initialized with World Bank data.
	Resource Export Dependence	Percentage of exports that come from energy, initialized from various sources.
	Rate of Per Capita GDP Growth	GDP divided by population and the rate of change therein across time, initialized from various sources.
Health	**Infant Mortality**	Number of children dying in their first year of life per 1,000, initialized with World Health Organization data.
	Life Expectancy	Number of years of average life at birth in a given year, initialized with World Health Organization data.
	Malnutrition	Percentage of people who suffer from malnutrition, considering both quality and

		quantity of caloric intake, initialized with World Health Organization data.
	HIV Prevalence	Percent of population with HIV/AIDS, initialized with World Health Organization data.
Education	**Primary Net Enrollment**	Percent of eligible students who attend primary school, initialized with UNESCO data.
	Adult Education Years	Average number of years spent in formal education for a person aged 15 and above, initialized with UNESCO data.
Population	**Youth Bulge**	Percent of the population aged 15-29 as a share of total adult population, initialized with United Nations data.
	Elderly Bulge	Percent of the population above 65 years as a share of total adult population, initialized with United Nations data.
	Urbanization Rate	Percent of the total population that migrates to urban areas, initialized with United Nations data.
Environment	**Water Use as a Percentage of Total Renewable**	Percent of fresh water resources used in a given year, initialized with AQUASTAT data
	Climate Change	Percent change in agricultural yields relative to 1990 levels stemming from climate change (change in temperature and precipitation along with carbon fertilization) initialized from various sources.

To take the above sub-components and calculate the Government Risk Index, each sub-measure is indexed. This is the process of dividing the current value of a country by the upper threshold for all countries across time. Next, each of the sub-index values are averaged.

In general terms, the Government Risk Index is forecasted in the Base Case to improve across time. The line graph below demonstrates the behavior of this index for World Bank regions. Here, lower levels indicate more domestic stability. High income countries—the grey line at the bottom—are the most stable across time, with the next closest region—Latin American and the Caribbean—not achieving their level of stability in 2010 even by 2050. The world average improves by nearly 16% across this time horizon. In terms of relative improvement, South Asia and Sub-Saharan Africa both improve their domestic security relatively more quickly than either the Middle East and North Africa or East Asia.

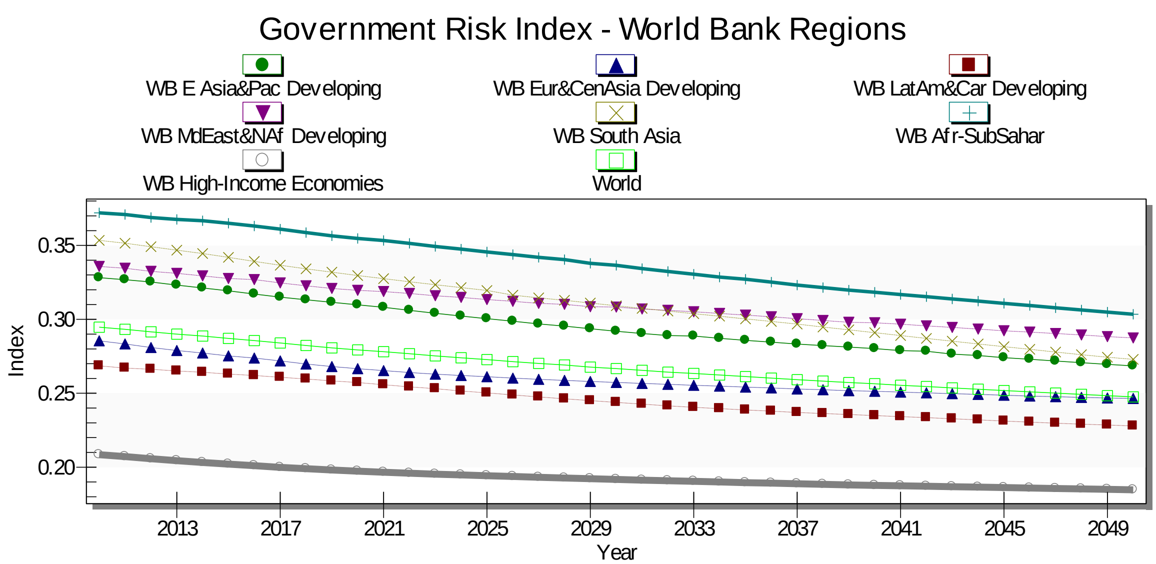

Figure 98: Government Risk Index Scores - World Bank Regions

Across the entire forty year time horizon, there is not one country whose 2050 value exceeds its 2010 value, indicating that all countries improve in stability. The countries that experience the smallest improvement in their domestic security are forecast to experience future problems, including large increases in elderly populations, low rates of growth in per capita income and negative impacts from climate change. The five countries that improve the least—in absolute terms—are New Zealand, Spain, Barbados, Cyprus and Portugal. Other countries improve their domestic stability situation significantly. Angola shows the greatest improvement in the forecast reducing their value from the fourth most unstable in 2010 to the average for East Asia and the Pacific in 2050. Nigeria, Mozambique and India also are forecast to greatly improve their domestic security situations.

The trends in the Governance Risk Index at the country level are also seen at the dyad-level. When comparing the average Dyadic Realist Index score for each country and the world (without considering the impact of Great Powers), 37 countries have an overall reduction of more than one standard deviation. The countries with the greatest reduction—in order—are Angola, Nigeria, Sudan, Afghanistan and the Republic of Congo. See Appendix 7 for a full list of state fragility forecasts to 2050 in IFs.

Table 18: Change in Average Dyadic Score for State Fragility

Change in Average Dyadic Index Score for Country and World for State Fragility from 2010 to 2050					
Greatest Improvement			**Least Improvement**		
	Absolute Score in 2050	**Improvement in 2050 over 2010 value**		**Absolute Score in 2050**	**Improvement in 2050 over 2010 value**
Angola	0.539	2.517	**Togo**	0.021	0.386
Nigeria	0.907	1.857	**Bosnia**	0.731	0.513
Sudan	-0.1	1.777	**Libya**	0.177	0.554
Afghanistan	-0.467	1.7	**Tonga**	0.898	0.593
Congo, Republic of	0.385	1.651	**Guinea Bissau**	-0.022	0.613
Equatorial Guinea	0.688	1.608	**Mauritania**	0.021	0.614
Mozambique	1.001	1.43	**Congo, Democratic**	-1.439	0.621

			Republic of		
Ethiopia	0.763	1.418	**Benin**	0.72	0.639
Papua New Guinea	0.578	1.39	**Serbia**	1.09	0.639
Turkmenistan	0.561	1.299	**Madagascar**	0.07	0.645

Including Great Powers into this analysis mirrors many of the conclusions drawn in the previous section regarding the Dyadic Realist Index and changes in relative power distributions. The Base Case of IFs forecasts that four countries will move from Great Power status to Non-Great Power Status out to 2050. These four—as noted above—are Russia, United Kingdom, France and Germany. When included in the Dyadic Realist Index for State Fragility, they become the four countries that, on average with the rest of the world, see the greatest reduction in their vulnerability to Realist pressures stemming from state fragility. Again, this conceptually relates to the decreased global responsibility—and capabilities—that keep a Non-Great Power from being unilaterally active in policing issues of domestic instability.

Moving from the level of average country Dyadic Realist Index scores to the actual dyad scores highlights the specific dyads that are more likely to experience pressure stemming from domestic instability. Currently, the lowest Dyadic Realist Index score related to state fragility is any relevant country—those contiguous and those who are Great Powers—and Somalia. The next dyads at greatest pressure related to state fragility are those countries that score the worst on the Government Risk Index. These are, in order, Somalia, Afghanistan, Democratic Republic of Congo, Angola and Sudan. In 2050 the distribution of the dyads that most experience Realist pressures related to domestic instability also correlate to the most unstable countries then, in order from most unstable, Somalia, Democratic Republic of Congo, Afghanistan, Chad and Myanmar. 88.3 percent of all dyads do not experience any pressure stemming from measures of domestic instability. These dyads are not contiguous and do not have one member that is a Great Power. Of the remaining 11.7 percent of dyads, no dyads experience an intensification in their Dyadic Realist Index score relating to State Fragility because no state in the Base Case of IFs shows a deterioration in their domestic political stability.

The impact of the four falling Great Powers can be seen in those dyadic relationships that experience less impact from Realist pressures stemming from State Fragility. The four falling Great Powers see their Dyadic Realist Index scores improve considerably, in some cases by as much as 5 standard deviations. The y axis below is the absolute number of standard deviations that a dyad has changed comparing 2010 and 2050 for the Dyadic Realist Index for State Fragility. The x-axis is a sorted number of dyadic observations, from least change being closest to the graph origin and most change further to the right. The right 35 percent of this graph shows how four falling Great Powers change their perception of state fragility in the international system. The higher a dyad scores on the y axis below, the lower the importance of state fragility in material resource decision-making.

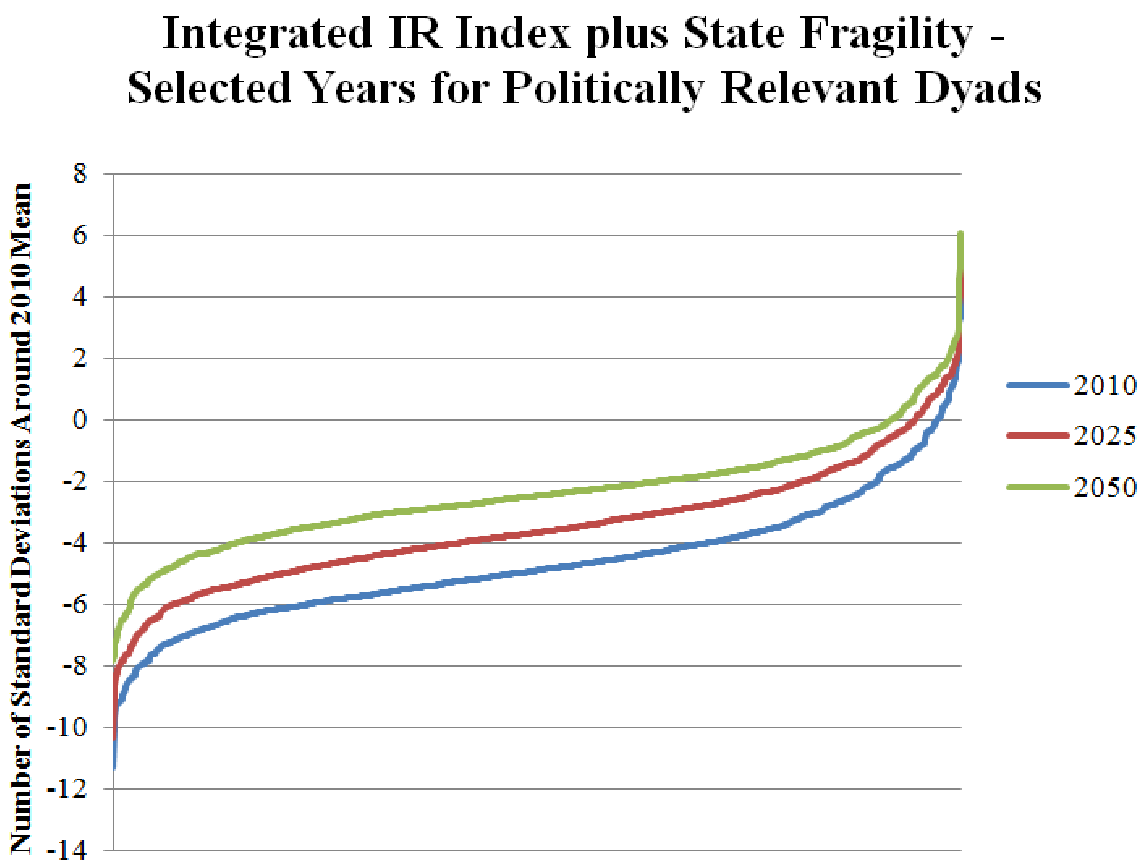

Figure 99: Integrated IR Index plus State Fragility - Selected Years for Politically Relevant Dyads

Removing the impact of the falling Great Powers does little to change the generally positive forecast for domestic instability within IFs. While all dyads improve across time, those that improve the most correspond to those countries (discussed above) that show great improvement in domestic stability. These include countries like Angola, Nigeria and Sudan and their politically relevant dyads. Dyads that show the smallest improvement include Japan and Barbados, USA and Barbados and Japan and Spain. Again, while these three dyads improve (at the lowest, by 5 over the 2010 value) they improve the least. By 2050, the dyads that experience the highest level of threat from the Dyadic Realist Index related to State Failure reflect those states that are forecast to have the worst Government Risk Index scores, discussed above. These include Somalia, Democratic Republic of Congo and Chad.

Fossil Fuel Resources

Moving through the next four decades, fossil fuel resources will continue to remain a fundamental input to global economic production. IFs does not forecast peak oil—where global production goes into steep decline—but rather a peak plateau—where production neither declines or increases as the cost of fossil fuel production is made less lucrative by renewable energy. While fossil fuels remain fundamentally important, they also become consolidated in the hands of fewer states. Some of these states—like Qatar and Turkmenistan—are likely to move from proximate players in the fossil fueled economy to central stars. This will shift how Great Powers interact with states with large fossil fuel resources in order to keep prices from becoming either too high or too low—a condition that would either cripple the global economy or producers.

Currently, fossil fuels make up nearly 90% of total global energy production. This crucial input to the global economy comes from three sources: natural gas, oil and coal. Natural gas and oil are responsible for just over 30% of total energy production, while coal is responsible for nearly 25%. In the Base Case, fossil fuel energy production as a share of total energy production declines to 2050, eventually representing nearly 60% of total global energy production. At this time, the three components of fossil fuels each represent around 20% of total energy production, a fundamental and large component to total production. The largest reduction in fossil fuel production comes from non-OPEC countries, increasing the future importance of that political association (Bielecki 2002).

Fossil fuels are traded on global markets. Casper Wienberger—former Secretary of Defense for Reagan—referred to the Middle East as the, "…umbilical cord of the free industrialized world" (Jhaveri 2004, 4). The implication for this is that prices are determined by equilibrium between global supply and demand. As no one country controls either supply or demand, the market for oil should be relatively stable, with no state having sway over the machinations of the movement of resources into our out of supply.

Even though global cartels exist to control the price of oil—though none currently controls the price of gas—their influence tends to be mitigated by their desire for government revenue which necessitates keeping global energy prices at levels that promote global consumption. The Organization for Petroleum Exporting Countries (OPEC) currently keeps global oil production at levels that both promote global economic growth (oil that is too expensive hinders growth) yet high enough to not over-draw reserves and keep sufficient funds flowing to their domestic coffers.

Because fossil fuels are traded on a global market they become less of a determinate of bilateral state relations for contiguous pairs. Think about Venezuela and Columbia. Decisions made in Bogota and Caracas have little to do with Venezuela's large oil reserves and Columbia's relative dearth. It is known by Columbia that—if Venezuela were to shut off the tap and stop trading oil bilaterally, that they could go to global markets to satisfy domestic energy demand.

While fossil fuel resources do not play into decision-making for all traditionally defined politically relevant dyads (those with at least one Great Power and/or territorial contiguity), they are for those that contain a Great Power and a state with large fossil fuel resources. The United States, for example, is interested in keeping the supply of oil and natural gas freely flowing to promote global economic growth (Barnes and Jaffe 2006). Countries with large oil and gas reserves are the focus of much US diplomatic engagement, and occasionally military action. See Yergin's *Foreign Affairs* piece on the importance of energy security for G-8 countries (Yergin 2006; Yergin 1991).

It is not coincidence that many have argued that fossil fuels play a role in the decision-making of Great Powers. Many have linked historic US foreign policy decisions—such as the occurrence of conflict—with a country's level of overall fossil fuel resources. Most recently, the 2003 invasion of Iraq was connected to fossil fuels by Jhaveri, who argues that the massive existing and potential reserves of oil were a key driver of the decision to go to war, initially citing writing by Donald Rumsfeld, Paul Wolfowitz and Richard Perle from 1998 indicating that Saddam Hussein's existence in power jeopardizes a large amount of fossil fuel resources (2004). Other authors speculate about the impact of the rise of China and their foreign policy related to fossil fuels (Downs 2004).

This section measures the Dyadic Realist Index for Fossil Fuel pressures between dyads. It makes the claim that politically relevant dyads in this arena involve at least one state is a great power and the other to contain large fossil fuel reserves. It then takes the fossil fuel reserves of gas and oil for the most endowed partner and divides them by the global total. States with very high levels of fossil fuel in dyads with Great Powers will produce scores that indicate that fossil fuels play into material decisions taken related to foreign policy within that dyad.

IFs forecasts global energy production by six types: oil, gas, coal, hydro, nuclear and renewable. The Base Case shows global production of fossil fuels to increase until the mid-2030s and then plateau. However, this stagnation in growth in fossil fuels occurs at a time when global energy production is on the incline. This is due to the massive increase in growth in renewable energy resources. The line-graph below demonstrates this massive transition in global energy production to 2050. By the end of this time horizon, renewable energy is forecast to provide more than twice the amount of energy than oil today.

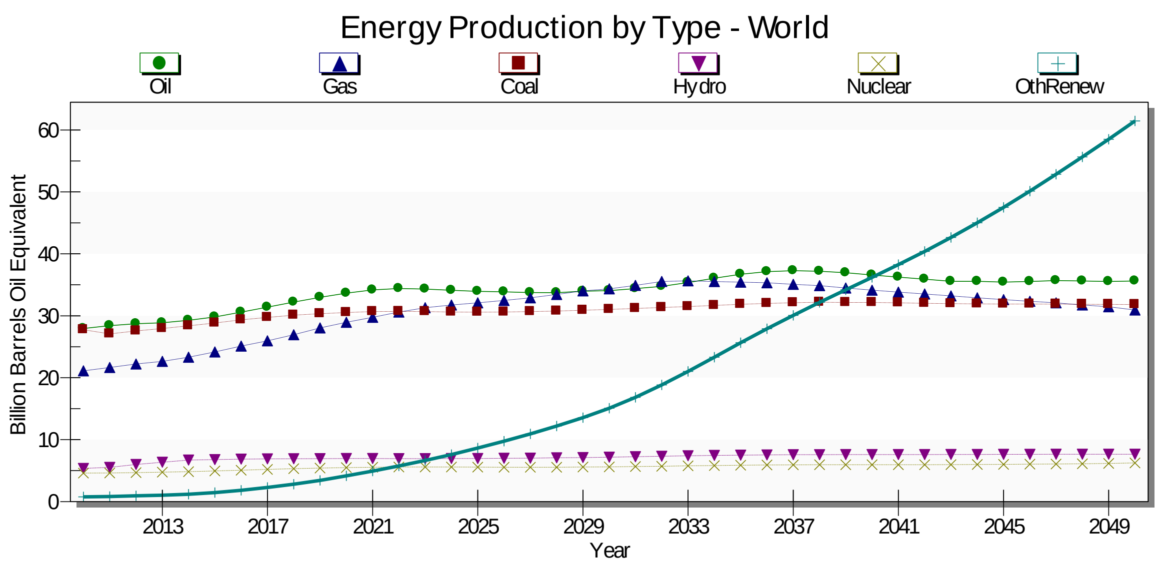

Figure 100: Energy Production by Type - World

The impressive increase in renewable energy occurs because it becomes relatively less costly to produce than alternatives. This is due to two things: first, fossil fuels become more expensive to produce as technological improvements that reduce cost are out-stripped by deeper wells, less pure oil and more hazardous drilling environments. Second, the cost of renewable energy declines as new technologies decrease the investment required to build solar panels, turbines, etc and the transportation infrastructure gradually transitions from a singularly fossil fuel driven framework to a fossil fuel/electricity hybrid framework.

Not only do fossil fuels remain a crucial component of global growth for the next four decades, but they become increasingly isolated in the hands of fewer and fewer large producers. Across this time horizon OPEC goes from producing 40% of the world's total oil to over 70%. The three countries with the highest levels of reserves—Russia, Iran and Qatar—move from production today of nearly 25% of total natural gas to nearly 50% by 2050.

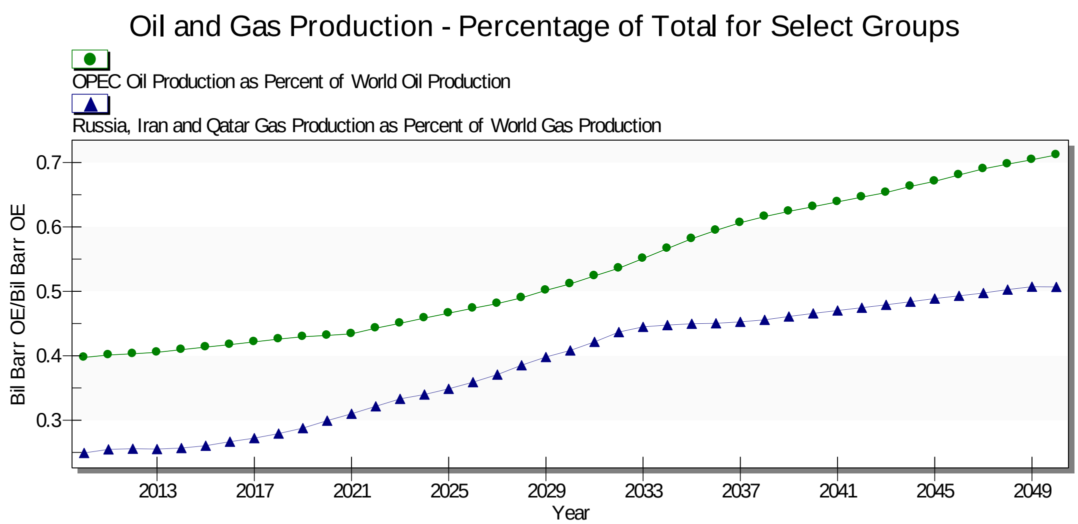

Figure 101: Oil and Gas Production as Percent of World Total - Selected Groups

An increase in the concentration of fossil fuels and their continued importance across the time horizon indicates that there is likely to be an increased pressure from the Dyadic Realist Index across time. This is not true at a global level, and for the same reason as discussed above: the absolute number of Great Powers declines across this time horizon. Conceptually, this means that there are fewer states with the will and ability to impact the decisions made by states that are relatively large holders of fossil fuels.

Take the global average for the Dyadic Realist Index measuring fossil fuels—with no falling Great Powers included—demonstrates that this will be an issue of increasing importance across time. The line-graph below demonstrates this pressure. It remains relatively stagnant for the next 30 years and then begins to deteriorate. The increasing Realist pressure from this measure occurs in those states that remain large producers of oil and gas across this time horizon.

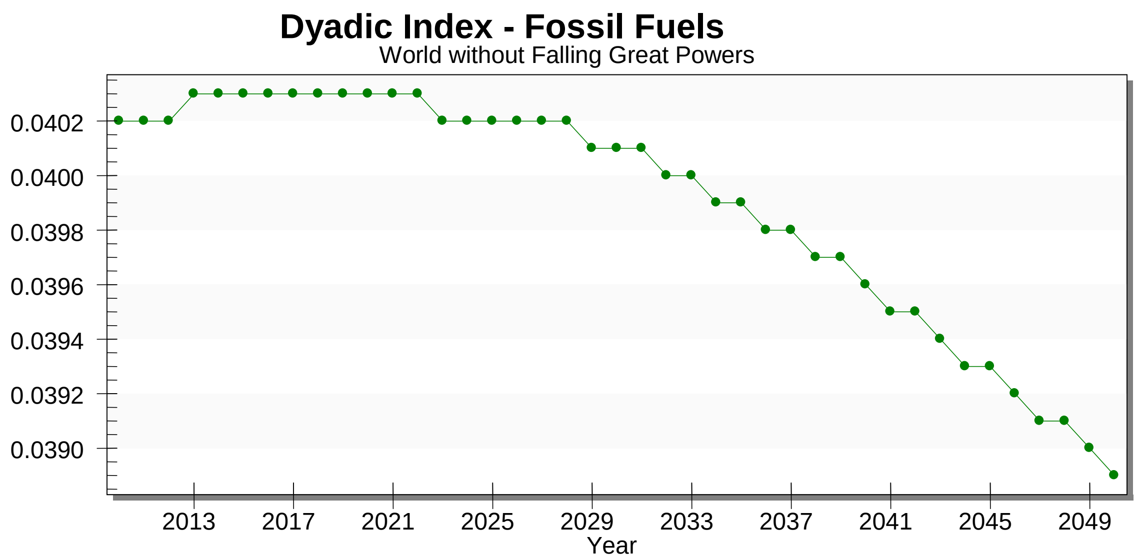

Figure 102: Dyadic Index for Fossil Fuels - World Average

On a country-average basis, the country with the lowest global average Dyadic Index score for fossil fuels—indicating that these resources play into their foreign policy decision making more broadly than any other country, is Russia. Russia has the world's largest reserves of natural gas (with more than 50% more than the second largest gas reserves in Iran) and also substantial reserves of oil (the world's 7th largest reserves overall). They also begin the time horizon as a Great Power, thus making the size of fossil fuel reserves in other countries germane to their own decision-making as well. The table below summarizes the top 10 countries in 2010 and 2050 for their average global Dyadic Index score for fossil fuels.

Table 19: Top 10 Dyads with Most Deteriorated Dyadic Index for Fossil Fuels

Top 10 Dyads with Most Deteriorated Dyadic Index Score for Fossil Fuels between 2010 and 2050	
Russia	USA
Iran	Brazil
Saudi Arabia	China
USA	India
China	Japan
Brazil	Saudi Arabia
India	Iran
United Kingdom	Russia
Germany	Qatar
France	Venezuela

The dyads where fossil fuels play the largest role are those with a member that has great reserves, at any point in time. The dyadic relationships that experience the largest amount of overall deterioration are those with one member that has a large amount of fossil fuel resources that are currently under-developed. Dyads with one Great Power and the following countries will experience an increasing importance of fossil fuel resources in their political decision-making: Russia will become an increasingly important country for mainly natural gas, but also oil reserves. With their decline as a Great Power, their reserves will become an increasingly important feature of international life moving forward. Saudi Arabia will become an increasingly important player in foreign policy decisions surrounding fossil fuel due to their massive oil reserves. Iraq—having the second largest overall oil reserves—will also continue to be an increasingly important player in this realm. Qatar has huge natural gas reserves—the world's third largest—but they remain only a medium-sized producer of natural gas—currently the world's 10th largest. This will rectify, and Qatar will become an increasingly important player in the world of natural gas production, and thus an increasingly important country when it comes to foreign policy decisions involving fossil fuels. Finally, Turkmenistan will represent an increasingly important country regarding fossil fuel foreign policy decisions. They currently have the world's fourth largest reserves but are the world's 31st largest producer. This discrepancy will unlikely stand.

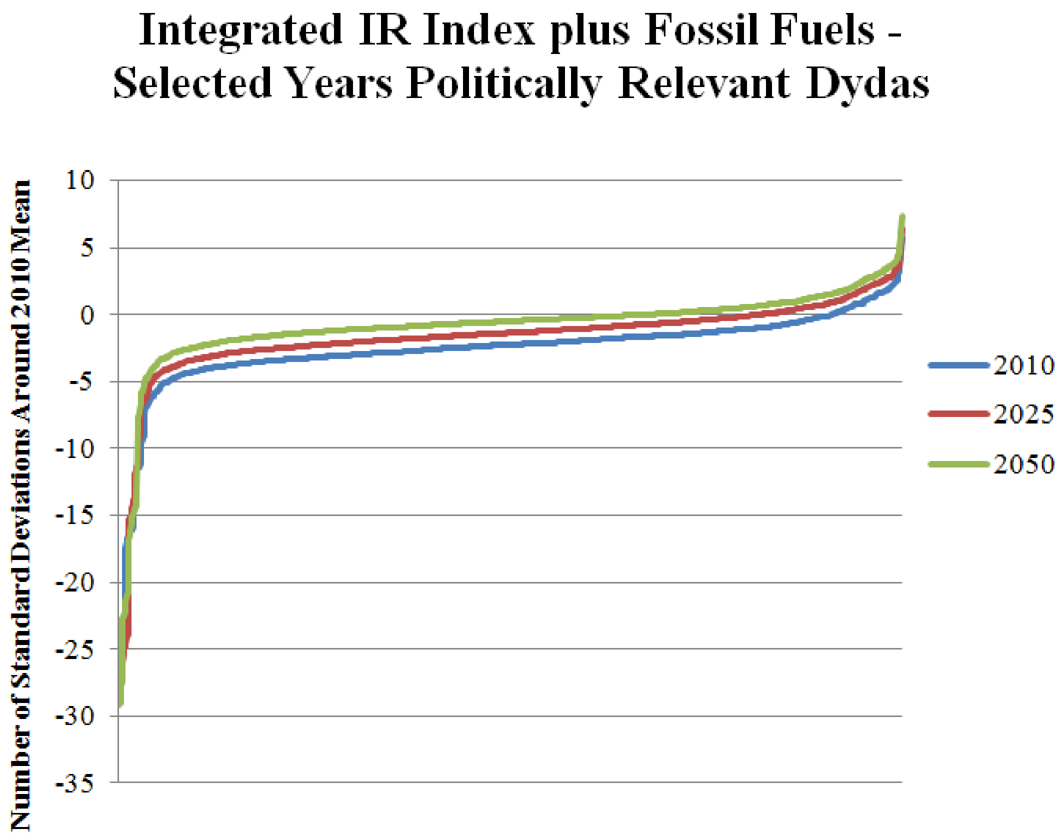

Figure 103: Integrated IR Index plus Fossil Fuels - Selected Years Politically Relevant Dyads

Overall Deep Drivers of State Behavior

I combine the different Deep Driver pressures described above to highlight dyads and countries that experience multiple pressures. These pairs of states may be more vulnerable to deteriorated relations across time. The next section of this Chapter 7 brings these deep drivers together with the Integrated IR Index to identify the most vulnerable dyads to conflict in the international system moving forward in a more comprehensive measure. I reiterate that I am not deploying a conceptual framework for evaluating exactly how these deep drivers impact state behavior in isolation or conjunction.

A key trend ameliorating negative pressure moving forward is improvements in vulnerability to state fragility across time. State fragility—as operationalized in this project and defined earlier—is an index measure that captures general levels of human, social, economic, political and environmental development. For the lion's share of the world's countries these measures have been improving historically, and IFs forecasts this to continue for the next four decades. This general improvement in human development leads to an overall reduction in the chance that a state would experience a domestic instability event, which would lead to dyadic pressures on contiguous states and Great Powers.

While there is an absolute reduction in pressure stemming from state fragility, concerns arising from water resources and fossil fuel resources may increase in many regions. This will—in certain dyads—force resource availability to be a key component of decision making in foreign policy. See the table below for IFs Base Case treatment of various deep drivers.

Table 20: Base Case Behavior of Various Indices Related to Deep Drivers

Base Case Behavior of Various Deep Drivers of State Behavior			
	Global Average Dyadic Score	**Global Average Dyadic Score without Falling Great Powers**	**Countries/Regions of Focus**
Water Resources	Deteriorates	Deteriorates	Middle East, North Africa, Central Asia
State Fragility	Improves Significantly	Improves Significantly	Those moving from Low Income to Middle Income
Fossil Fuels	Improves	Deteriorates	OPEC Countries and Persistent Great Powers
Summary Index	Improves	Improves	Various

Of the over 16,653 dyad years explored in this exercise, 126 experience deterioration in the Deep Drivers of state behavior across the forty year time horizon representing 0.5 percent of the total. These 126 pairs of states represent 6.5 percent of politically relevant dyads (sample size of 1,944). The majority of dyads in the international system do not experience negative pressure stemming from changes in the deep drivers, discussed above, even without mitigating impacts from Liberalism and improvements in the stock of cooperative culture. The change in this pressure on a dyad basis across time is represented in the line-graph below, which organizes dyads by selected years from most pressure (to the left) to least (to the right). The majority of dyads that are politically relevant experience little to no pressure. A handful of these dyads (about 10 percent) experience increasing pressure. Across time, the majority of politically relevant dyads see reductions in these pressures. However, the lower 10 percent experience these pressures being as acute as they are today or actually deteriorating.

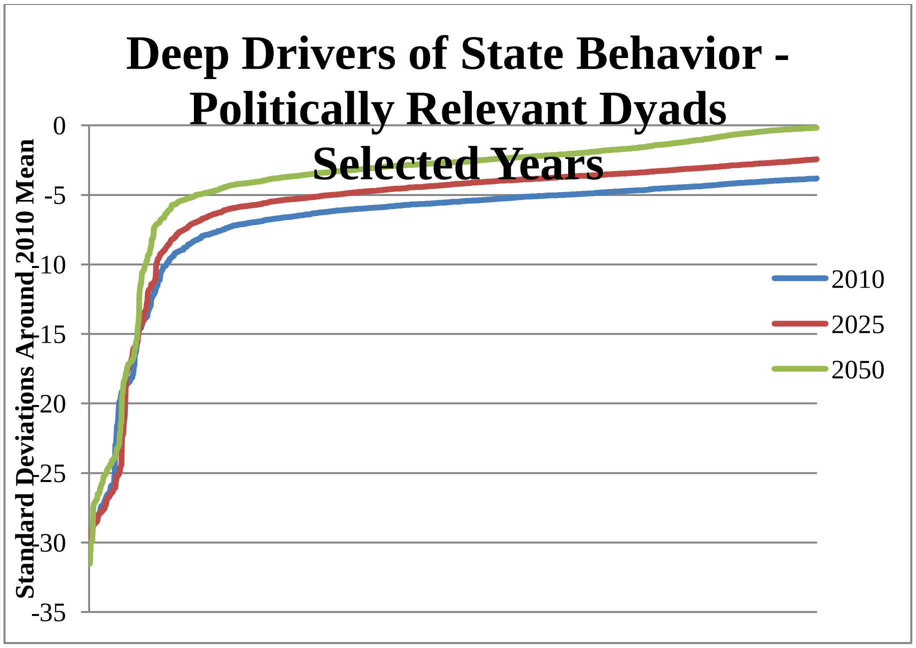

Figure 104: Deep Drivers of State Behavior - Politically Relevant Dyads Selected Years

While most dyads enjoy less pressure in 2050 compared with 2010, some dyads are forecast to experience deteriorated relations based on the aggregation of these three deep drivers of state behavior between 2010 and 2050. The reduction in scores occur in water resources and changes in the production of fossil fuel resources as pressure from state fragility reduces across the time horizon (noted above). The table below lists the 64 countries that are members in a dyad that experiences a reduction in their deep driver score across this time horizon along with the number of dyads that they experience a deteriorated interaction. The majority of these countries experience deterioration in *either* water or fossil fuel scores and not in both, and many have state fragility scores that improve only slightly.

Table 21: Dyads with Total Number of Relationships Deteriorated from 2010 to 2050 for Deep Drivers of State Behavior

Dyads with Total Number of Relationships Deteriorated from 2010 to 2050 for Deep

Drivers of State Behavior							
Japan	16	Syria	5	Mauritania	3	Cyprus	1
China	14	Venezuela	5	Morocco	3	Djibouti	1
India	14	Algeria	4	Somalia	3	Eritrea	1
Iran	12	Australia	4	Ethiopia	2	Georgia	1
USA	12	Egypt	4	Germany	2	Lithuania	1
Brazil	11	Kyrgyzstan	4	Israel	2	Luxembourg	1
Iraq	10	Pakistan	4	Jordan	2	Moldova	1
Turkmenistan	8	Spain	4	Kenya	2	Mozambique	1
Sudan	7	Tajikistan	4	Mali	2	Myanmar	1
Turkey	7	Uzbekistan	4	Norway	2	Nepal	1
Afghanistan	6	Armenia	3	Swaziland	2	Netherlands	1
Russia	6	Belgium	3	Ukraine	2	Poland	1
Azerbaijan	5	France	3	Bangladesh	1	Tunisia	1
Qatar	5	Italy	3	Bhutan	1	Uganda	1
Saudi Arabia	5	Kazakhstan	3	Central African Republic	1	United Kingdom	1
Suriname	5	Lebanon	3	Chad	1	Zimbabwe	1

Many of the countries at the top of this list are Great Powers and all experience dyads that deteriorate because of increased pressure stemming from the centralization of fossil fuel production. The logic here is that changes in fossil fuel production will increasingly dominate some relationships (as described above). Removing Great Powers from the equation, however, produces a slightly different story and highlights specific states that are likely to experience increasing pressures from these drivers. The word cloud, below, takes the data presented in the table above *sans* Great Powers. It shows only countries that are members of a dyad that experience a deterioration across this time horizon stemming from these three drivers and the font size corresponds to the number of dyads in which they experience a reduction. It largely highlights dyads where state fragility improves only slightly and where water resources are becoming a more acute issue. The countries on this list—especially those in large fonts—have historically experienced conflict. It is certainly worrisome to see both Iran and Iraq as two countries that are forecast to experience a large number of problematic dyadic relations. Additionally, Central Asia remains a point of concern with Turkmenistan representing a focal point for possible future conflict over Deep Drivers of state behavior.

Figure 105: Non-Great Powers with Deteriorated Relationships based on Three Deep Drivers of State Behavior - Size of Font Equals Number of Deteriorated Relationships from 2010 to 2050

Assessing the behavior of deep drivers of state behavior without also considering changes in the Integrated IR Index is misleading. In fact, the increasing pressure faced by the countries in the word cloud above might be entirely off-set by improvements in culture and increased interdependence. To more fully assess the future of interstate relations I combine the deep drivers with the Integrated IR Index.

Behavior for Overall Combined Index

The future for dyadic conflict, on a global basis, is rosy. To a large degree the world is becoming more interdependent in both simple and complex ways. These interdependencies create space for dyads to engage in virtuous cycles of foreign policy that may lead to the lasting peace envisioned by Kant: more trade leads to more shared IO membership and more thorough alignment of foreign policy interests in the international system. Historic development would also indicate that the culture of interstate interaction is moving towards more cooperation and away from more conflict. These are all good things.

Not only are interdependencies deepening across the globe, but some negative pressures are also on the decline. The next four decades show a decline in foreign policy pressures related to material power considerations. This is based primarily on two powerful trends. First, there is a reduction in the number of Great Powers in the international system. The forecasts indicate that the falling Great Powers—Russia, Germany, France and the United Kingdom—no longer have the ability to exert power as effectively over the next 40 years. Such a reduction in the number of states with the capacity to exert foreign policy influence widely would lead to an absolute reduction in the overall amount of pressure stemming from relative material power considerations in foreign policy decision making.

Additionally, international pressure stemming from domestic instability—leading to wars of opportunity (Iran and Iraq in the 1980s) or wars of neighborhood or international stability (Kenya and Somalia in 2012, or the US and Somalia in the 1990s)—are forecast to decline substantially. Domestic instability events have been on the decline since the end of the Cold War, and I expect this transition to continue, driven largely by increased levels of education, health and income.

While the forecast for international conflict is generally positive, there are exceptions. Some pressures persist—either stemming from the Realist Index or Deeper Drivers explored in this chapter—and even intensify. First, the global shift from a unipolar world with multiple second-tier Great Powers to a world of three first tier Great Powers and two second tier Great Powers could lead to conflict. There is great uncertainty surrounding the rise of China and India and whether and how it will lead to shifting alliances and new proxy-conflicts, *ala* the Cold War. Second, other global power transitions may lead to conflict in specific regions. In Central Asia, Turkmenistan is forecast to grow significantly supported by very large natural gas reserves. Currently one of the smaller powers in the region, it is likely to grow into one of the largest over the next four decades. Shifts in material power concentrations can upset former patterns of foreign policy interaction and can lead to conflict.

In certain regions water resources are becoming scarcer, and this could lead to conflict. Currently, levels of water stress are highest across the Arabian Peninsula, with many countries and dyads already drawing down water tables and importing fresh water. Pressures in these dyads are forecast to continue to increase. The largest new threat from water resources in dyads that share river basins comes in Central Asia, South Asia, North-East Africa and parts of the Middle East. Fossil fuels will also continue to play a critical role in the future of dyadic international relations. While renewable energy is forecast to grow into a (if not the) critical source of global energy demands, fossil fuels will remain available and cost-competitive for certain activities (such as space travel or jet flight, among manufacturing and fertilizer use). While many states will pump away their fossil fuels over the next two decades, states with large reserves will remain crucially important—even relatively more important than they are today—when it comes to energy production.

The final output of this project is a measure of the overall threat that a dyad experiences in any year. This is a simple aggregation of Kantian Liberal, Cultures of Interaction, Realist, Fossil Fuel, State Fragility and Water Resource Indices. The three curves in the line-graph below demonstrate how this index distributes for all dyads in the international system in 2010, 2025 and 2050. It is sorted—from left to right—by most overall threat to the least. First, the curves shift up across time indicating that the majority of dyads in the international system are forecast to experience better relations across time. A second characteristic of this line graph is the extremes of the distribution: Both dyads with very good levels of dyadic interaction—and, as a counter, very low levels of threat—and those with very high levels of threat represent a very small percentage of the distribution in 2010, and this distribution does not change significantly across time. There exists a cohort of dyads in each time period with extremely positive and negative relations.

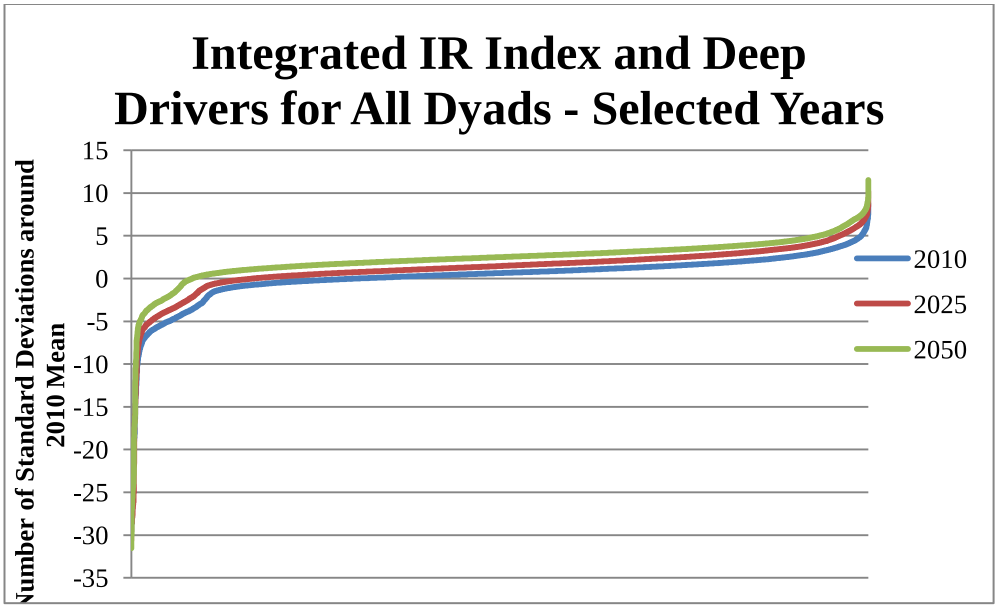

Figure 106: Integrated IR Index and Deep Drivers for All Dyads - Selected Years

The majority of dyads experience improved relations across time. However, there are some that do not. These pairs of states do not see the ameliorating impacts of interdependence operationalized in the Liberal Index out weight increased pressures from the combination of shifts in relative material power, state fragility, water resources and fossil fuels. The table below highlights countries and the number of relationships that they are a part of that experience reductions.

Dyads with Total Number of Relationships Deteriorated from 2010 to 2050 for Integrated IR Index and Deep Drivers of State Behavior							
Iraq	10	Egypt	4	USA	3	Israel	1
Mauritania	10	India	4	Uzbekistan	3	Jordan	1
China	7	Pakistan	4	Ethiopia	2	Lesotho	1
Iran	7	Turkey	4	Kenya	2	Mali	1
Sudan	7	Chad	3	Swaziland	2	Mozambique	1
Afghanistan	6	Kazakhstan	3	Armenia	1	Myanmar	1
Kyrgyzstan	6	Lebanon	3	Australia	1	Nigeria	1
Algeria	5	Morocco	3	Azerbaijan	1	Solomon Islands	1
Japan	5	Somalia	3	Central African Republic	1	Spain	1

Russia	5	Syria	3	Djibouti	1	Tunisia	1
Saudi Arabia	5	Tajikistan	3	Ecuador	1	Uganda	1
Brazil	4	Turkmenistan	3	Eritrea	1		

The countries in the table above are the ultimate result of this project, and represent countries that have long-term interstate security concerns, some more than others. Iraq and Mauritania top the list, both with 10 dyadic relations that are forecast to reduce in character across the time horizon. This is so for various reasons. First, neither state is forecast to become very liberal, though Iraq becomes more liberal than Mauritania by becoming an increasingly important producer of fossil fuels. However, the production of fossil fuels in Iraq becomes an important pressure in their relations with Great Powers: because they become increasingly important in this issue area, their domestic policy choices are increasingly put under pressure. Both of these states are in regions where fresh water use is already very high, and this is forecast to increase. Both Mauritania and Iraq are also in neighborhoods where pressures from state fragility remain relatively high.

The top seven states in the table above—Iraq, Mauritania, China, Iran, Sudan, Afghanistan and Kyrgyzstan—all share characteristics. They share contiguous borders with many states, remain fairly illiberal across the time horizon, share river basins that are over-stretched and have regional issues with state fragility that are forecast to continue. The largest number of states in the table above is located in the Middle East and North Africa (14 out of 47 states) followed by Sub Saharan Africa (13) and Central Asia (8). Remaining countries are scattered across the globe.

Deterioration of bilateral relations across this number of important dyads is an important conclusion of this project. I have identified potential hot-spots using an integrated approach. Most notably, the future of interstate relations in Central Asia is contentious, as it experiences all of the pressures conceptualized in this dissertation. The great gas reserves of Turkmenistan will lead to its rise and transition to regional power status. This, coupled with pressure from water resources, illiberal governments and the continued specter of state fragility makes the region a potentially dangerous zone moving forward. The Middle East and North Africa both remain concerns moving forward, as do selected areas in Sub-Saharan Africa, most notably around the river basin that stretches from Ethiopia to Egypt.

Conclusion

For the most part, the character of bilateral relationships in the international system seems likely to improve over the next four decades, though challenges will persist. Overall, this Base Case analysis forecasts that relationships will generally strengthen, diplomatic ties will increase and some Realist pressures will decline. That said there are still regions and dyads that will experience high levels of structural pressure that may lead to deterioration in the character of their interaction. Much of this pressure will come from increased pressures around water, fossil fuels and material power transitions in dyads with already low levels of Liberalism.

It must be reiterated that these forecasts are from the Base Case of the IFs system. Future work must focus on exploring uncertainty around this forecast through the creation of scenarios. While the Base Case is a good place to start, it certainly is not a sufficient place to end. Deterioration of globalization, state failure in China and many other destabilizing events could negatively impact the story outlined in this chapter.

8. Conclusions: Lots of Next Steps

This dissertation contributes to the fields of International Relations (IR) and Integrated Assessment Modeling by operationalizing historic measures of IR theory from 1960 to 2001 and forecasting these indices from 2010 to 2050 in the International Futures (IFs) model. In this project, I build a tool that can be used to quantitatively assess the character of interaction between all sovereign dyads across this long time horizon. This tool can be used to evaluate the logical outcomes of theoretical assumptions, produce policy relevant analysis, and can be used as a pedagogical tool for teaching about IR.I have used this dissertation to lay a foundation for a broader research agenda that creates macro level, structured representations of the behavior of states in the international system that are integrated across issue areas and that embrace pragmatism in analysis and not ideology. I have not fully succeeded in this goal. I have not, for example, fully structured a model of state interaction over long time horizons, nor have I shown how to deeply integrate IR theory quantitatively. With those shortcomings in mind, I have attempted to present myself as being opposed to the following three perspectives:

First, much quantitative analysis in the field of IR is not structured, and relies on statistical evaluations of drivers of one dependent variable or another. Purely statistical approaches to doing analysis—for example, those deployed by Bennett and Stam (citation)—are useful for pushing towards quantitative verification of theoretical perspectives, but they must be augmented with model building approaches that embrace formal structure. By that, I mean that it is problematic to evaluating the historic onset of conflict by throwing every theoretical perspective into a model and seeing what emerges. An alternative to this is an approach that starts with a structured representation of theory (how material power interacts with alliance building, and how that drives culture, etc) and builds up. I began to do this, but fell well short of a fully structured model of international interaction across long time horizons. That failure in mind, I did approach the problem of measuring the character of state interaction from a systems theory and structured perspective.

Second, this dissertation presents an integrated approach to doing analysis, both from a quantitative perspective as well as a qualitative perspective. The IFs system is unique in providing a wide range of quantitative integration across key global systems. I augment that by arguing that IR theory should also be treated as an integrated whole and not as separate islands of insight that are to be drawn from. I show through statistical analysis that this is reasonable, though my integration of IR theories is only of the most thin kind (simple aggregation).

Finally, this dissertation challenges those would embrace IR theory from perspectives that are ideologically driven. It is not true that relative material power is a tranhistorical fact in the same way that it is not true that interdependence is a panacea.

Instead, these different perspectives have the ability to provide ranges of insight that should be seen as complimentary. This dissertation demonstrated that.

More specifically, this project creates historic measures of IR for all dyads from 1960 to 2001 by measuring Liberal, Realist and the Cultures of Interaction indices. I improve on the previous operationalization of these indices in the following ways. First, I create a new data set (country embeddedness in treaties held by the UN secretariat) and integrate that data into the historic and forecast measure for Liberalism. Second, I historically operationalize a measure of relative material power (using the Hillebrand/Herman method) that previously did not exist in the public domain. Third, I build a measure called the "Cultures of Interaction Index" (CoI Index) entirely from the dyad-level up. This index leverages conceptual elements of Liberalism (such as complex interdependences) and also attempts quantify, albeit imperfectly, a stock of cultural engagement between pairs of countries. Derivations of this measure have already been used in policy analysis both by and for the US government.[55]

This dissertation also contributes to the quantification of IR theory by showing that standard quantifications of Liberalism and Realism provide more explanatory power when used in concert to explain the historic occurrence of conflict than either do in isolation. I also show that the newly created measure of CoI Index adds to the overall explanatory power of the Liberal-Realist model. This logistic regression analysis

[55] A version of the Cultures of Interaction graph analyzed against the natural log of the Hillebrand and Herman Power Index is currently used in the draft of the Global Trends 2030 report, to be sent to the incoming US president this fall. Also, the CoI Index has been used as a foundation for two contracts with the US Intelligence Community and the Frederick S Pardee Center. The final output of that interaction will be a long-term forecast of relative diplomatic power.

provides further support for the assertion that general IR perspectives contain more explanatory power when used in conjunction than isolation, and analysts should see them as complimentary and not competing approaches to explaining behavior in the international system.

This project contributes to the abovementioned fields by endogenizing both Liberal and Realist indices within the IFs—and using the CoI Index exogenously—to model dyadic behavior over a 40 year time horizon. This work informs analysis about the changing character of dyadic interactions across long time horizons. The final output of this dissertation project has policy relevance and identifies specific dyads that are most likely to experience deterioration in the character of their interaction based on the IR indices modeled.

This project contributes to long-term understandings of distal drivers of conflict in the international system. Chapter 7 explores three theoretically relevant distal drivers of dyadic conflict—drivers that both impact IR theories along with dyadic relations between states. These are domestic state fragility, depleted water resources for dyads who share river basins, and shifts in fossil fuel production for dyads with one Great Power.

I conclude that the future of international relations is generally positive with increases in Liberalism likely to offset the majority of drivers of deteriorated relations, even Deep Drivers discussed in Chapter 7. That said, there are still problematic regions and relationships that deserve extended focus. Standard Realist pressures will exert themselves on specific dyads, notably around the relationship between China - India and China – US. Deep Drivers are forecast to have negative impacts on relations across the

Middle East, North Africa and Central Asia. Most notably, every country in Central Asia experiences at least one reduction in bilateral relations over the next forty years. Future work should include scenario analysis to frame more of the uncertainty in these forecasts and conclusions.

In terms of policy, this dissertation does not provide specific recommendations, such as “plan for war between Turkmenistan and Kazakhstan”. Instead, it extends the horizon across which policy planners can scan in order to allocate resources that help shape strategic alliances. Specifically, policy makers should be interested in the following:

- Gains in Classical Liberal drivers—trade, democracy and embeddedness in international political systems—are forecast to improve state relations across the great majority of dyads
- Pressures from relative material power are forecast to have destabilizing impacts on Great Powers relations in spite of gains made by Liberalism: China – India, China – US and India – US
- Stabilizing interventions brought about by state fragility are forecast to be less common, though some states remain concerns over the next four decades: Somalia, Democratic Republic of Congo, Afghanistan, Chad and Myanmar
- Fossil fuel production is forecast to become increasingly concentrated (mostly in OPEC countries) and will continue to remain a key for Great Power planning even as the world moves towards greater renewable energy production

- Water resources are forecast to become more constrained in key river basins (North-East Africa, Middle East, Central Asia), leading to the possibility of deteriorated relations among states in these regions
- The following states experience a confluence of pressures that do not outstrip gains from Liberalism, and should be of general concern: Iraq, Mauritania, China, Iran, Sudan, Afghanistan and Kyrgyzstan
- Central Asia remains a serious concern for deteriorated interstate relations driven by low levels of growth in Liberalism coupled with the rapid rise of Turkmenistan (and their increased importance as a gas exporter), pressure from water stress and slow improvement in state fragility

While this project has contributed to the field—both in terms of long-term forecasts and applied international relations analysis—there are certainly shortcomings. One of the most glaring is the lack of treatment of alliances and networks across countries. The real test of a dyads relationship has to do not only with the variables captured in this analysis, but also with variables that we have yet been unable to quantify. Whether the US and China enjoy stable relations moving forward is heavily contingent on the degree to which they are both embedded in a similar alliance network or whether they are embedded in distinct alliance networks with the emergence of a new bi-polar world.

While neglecting alliances has been a hindrance to analysis, our ability to think about the future of networks and relationships will be greatly enhanced by the variables created in this forecasting exercise. Specifically, the Cultures of Interaction index sub-components provide fertile ground for future research (perhaps using methods like cluster analysis) to determine political affinity historically in order to hopefully model it in the future. The work of this project essentially lays the foundation for future forecast work on alliances and networks.

The treatment of Great Powers in this work should be improved upon. I did not consider regional power dynamics. For example, in Chapter 6 I produced results showing that Iran and Israel enjoyed a reasonable relationship and we know that this is not the case. This criticism can be levied at other regions as well, including in the African context. One way to treat this with more nuance is to add an additional component to my algorithm that determines whether a dyad is politically relevant. Instead of being driven by a global power threshold, this could be driven by a regional power threshold that would capture the relationship between Iran and Israel, for example. A problem with this would be the identification of regional boundaries in a reasonable way.

As stated in Chapter 2, we are all stuck with the "problem of the future". We are compelled to find out as much as we can about what is likely to happen, but we have an absolute inability to know what events will transpire. This project has taken a mighty stab at trying to formally model and understand the future of interstate relations in the international system. It has demonstrated policy, pedagogical and theoretical relevance. It has also shown that we have good reason to expect a future international system that is generally better behaved than today, along with evidence to aim resources at mitigating conflicts that may emerge around the next bend of history.

Appendices

Appendix 1: Countries in International Futures

Afghanistan	Denmark	Liberia	Samoa
Albania	Djibouti	Libya	Sao Tome and Principe
Algeria	Dominican Republic	Lithuania	Saudi Arabia
Angola	Ecuador	Luxembourg	Senegal
Argentina	Egypt, Arab Republic of	Madagascar	Serbia
Armenia	El Salvador	Malawi	Sierra Leone
Australia	Equatorial Guinea	Malaysia	Singapore
Austria	Eritrea	Maldives	Slovak Republic
Azerbaijan	Estonia	Mali	Slovenia
Bahamas, The	Ethiopia	Malta	Solomon Islands
Bahrain	Fiji	Mauritania	Somalia
Bangladesh	Finland	Mauritius	South Africa
Barbados	France	Mexico	Spain
Belarus	Gabon	Federated States of Micronesia	Sri Lanka
Belgium	Gambia, The	Moldova	Sudan
Belize	Georgia	Mongolia	Suriname
Benin	Germany	Montenegro	Swaziland
Bhutan	Ghana	Morocco	Sweden
Bolivia	Greece	Mozambique	Switzerland
Bosnia and Herzegovina	Grenada	Myanmar	Syrian Arab Republic
Botswana	Guatemala	Namibia	Taiwan, China
Brazil	Guinea	Nepal	Tajikistan
Brunei	Guinea-Bissau	Netherlands	Macedonia, Former Yugoslav Republic of
Bulgaria	Guyana	New Zealand	Thailand
Burkina Faso	Haiti	Nicaragua	Timor-Leste

Burundi	Honduras	Niger	Togo
Cambodia	Hungary	Nigeria	Tonga
Cameroon	Iceland	Norway	Trinidad and Tobago
Canada	India	Palestine	Tunisia
Cape Verde	Indonesia	Oman	Turkey
Central African Republic	Iran, Islamic Republic of	Pakistan	Turkmenistan
Chad	Iraq	Panama	Uganda
Chile	Ireland	Papua New Guinea	Ukraine
China	Israel	Paraguay	United Arab Emirates
Hong Kong	Italy	Peru	United Kingdom
Colombia	Jamaica	Philippines	Tanzania
Comoros	Japan	Poland	United States
Congo, Republic of	Jordan	Portugal	Uruguay
Costa Rica	Kazakhstan	Puerto Rico	Uzbekistan
Cote d'Ivoire	Kenya	Qatar	Vanuatu
Croatia	Kuwait	Korea, Republic of	Venezuela
Cuba	Kyrgyzstan	Romania	Vietnam
Cyprus	Laos, People's Democratic Republic	Russian Federation	Yemen, Republic of
Czech Republic	Latvia	Rwanda	Zambia
Korea, Democratic People's Republic of	Lebanon	St. Lucia	Zimbabwe
Congo, Democratic Republic of	Lesotho	St. Vincent and the Grenadines	

Appendix 2: UN Treaty Categorization

The categorization of UN Treaties into sub-categories. Note, the "political" sub-category was not displayed above.

			Sub-Set 1	Sub-Set 2
1	CHAPTER I	Charter of the United Nations and Statute of the International Court of Justice	Political	
2	CHAPTER II	Pacific Settlement of International Disputes	Political	
3	CHAPTER III	Privileges and Immunities, Diplomatic and Consular Relations, etc	Political	
4	CHAPTER IV	Human Rights	Human Rights	
5	CHAPTER V	Refugees and Stateless Persons	Political	Human Rights
6	CHAPTER VI	Narcotic Drugs and Psychotropic Substances	Domestic	
7	CHAPTER VII	Traffic in Persons	Human Rights	
8	CHAPTER VIII	Obscene Publications	Domestic	
9	CHAPTER IX	Health	Political	
10	CHAPTER X	International Trade and Development	Economic	
11	CHAPTER XI	Transport and Communications	Economic	Political
12	CHAPTER XII	Navigation	Economic	
13	CHAPTER XIII	Economic Statistics	Economic	

14	CHAPTER XIV	Educational and Cultural Matters	Domestic	
15	CHAPTER XV	Declaration of Death of Missing Persons		
16	CHAPTER XVI	Status of Women	Human Rights	
17	CHAPTER XVII	Freedom of Information	Political	
18	CHAPTER XVIII	Penal Matters	Human Rights	
19	CHAPTER XIX	Commodities	Economic	
20	CHAPTER XX	Maintenance Obligations	Economic	
21	CHAPTER XXI	Law of the Sea	Political	Economic
22	CHAPTER XXII	Commercial Arbitration	Economic	
23	CHAPTER XXIII	Law of Treaties	Political	
24	CHAPTER XXIV	Outer Space	Political	Economic
25	CHAPTER XXV	Telecommunications	Political	Economic
26	CHAPTER XXVI	Disarmament	Military	Political
27	CHAPTER XXVII	Environment	Political	Environmental
28	CHAPTER XXVIII	Fiscal Matters	Economic	
29	CHAPTER XXIX	Miscellaneous	Political	

Appendix 3: Gravity Model Regression Results

Dependent Variable	**=**	**Level of Dyadic Trade**
Independent Variable 1	=	Log of GDP Summed
Independent Variable 2	=	Distance
Independent Variable 3	=	Year
Coef_of_X1:	=	1.69
Coef_of_X2:	=	.000385
Coef_of_X3:	=	.0129
Y Intercept	=	-39.43
R-Square	=	0.645
Adj R-Square	=	0.645
SE of Y-Intercept	=	1.15
SE_of_X1:	=	.0028
SE_of_X2:	=	.000002
SE_of_X3:	=	.000584
t-Value of Y-Intercept	=	-34.02
t-Value_of_X1:	=	605.77
t-Value_of_X2:	=	220.42
t-Value_of_X3:	=	22.17
Prob of Y-Intercept	=	<.0001
Prob_of_X1:	=	<.0001
Prob_of_X2:	=	<.0001
Prob_of_X3:	=	<.0001
Multiple R	=	0.781224
Std Error of Estimate	=	3.35

Appendix 4: Logistic Regression Results

Data Description	Independent Variable	Dependent Variable	R^2	Chi Square Test	Prob > Chi Square
Full Variables, 457k Rows	Liberalism Standardized	COW Direct Actors	0.0098	10.45	0.0012
Full Variables, 457k Rows	Realism Standardized	COW Direct Actors	0.131	139.75	<.0001
Full Variables, 457k Rows	Cultures of Interaction, Standardized	COW Direct Actors	0	0.01544	0.9011
Full Variables, 457k Rows	Aggregation of CoI, Liberal and Realism	COW Direct Actors	0.146	155.6	<.0001
Full Variables, 457k Rows	Aggregation of Liberal and Realism	COW Direct Actors	0.1403	149.52	<.0001
Full Variables, 457k Rows	Liberalism Standardized	MID Fatality	0.0037	35.48	<.0001
Full Variables, 457k Rows	Realism Standardized	MID Fatality	0.0792	757.98	<.0001
Full Variables, 457k Rows	Cultures of Interaction, Standardized	MID Fatality	0.0036	35.4544	<.0001
Full Variables, 457k Rows	Aggregation of CoI, Liberal and Realism	MID Fatality	0.0739	706.58	<.0001
Full Variables, 457k Rows	Aggregation of Liberal and Realism	MID Fatality	0.0824	788.32	<.0001
Full Variables with Realist	Liberalism Standardized	COW Direct Actors	0.0552	45.27	<.0001

Pressure, 67k Rows					
Full Variables with Realist Pressure, 67k Rows	Realism Standardized	COW Direct Actors	0.0579	47.46	<.0001
Full Variables with Realist Pressure, 67k Rows	Cultures of Interaction, Standardized	COW Direct Actors	0.0354	29.046	<.0001
Full Variables with Realist Pressure, 67k Rows	Aggregation of CoI, Liberal and Realism	COW Direct Actors	0.1001	82.05	<.0001
Full Variables with Realist Pressure, 67k Rows	Aggregation of Liberal and Realism	COW Direct Actors	0.0795	65.16	<.0001
Full Variables with Realist Pressure, 67k Rows	Liberalism Standardized	MID Fatality	0.0416	257.88	<.0001
Full Variables with Realist Pressure, 67k Rows	Realism Standardized	MID Fatality	0.0251	155.527	<.0001

Full Variables with Realist Pressure, 67k Rows	Cultures of Interaction, Standardized	MID Fatality	0.0244	151.511	<.0001
Full Variables with Realist Pressure, 67k Rows	Aggregation of CoI, Liberal and Realism	MID Fatality	0.563	348.856	<.0001
Full Variables with Realist Pressure, 67k Rows	Aggregation of Liberal and Realism	MID Fatality	0.421	260.88	<.0001

Appendix 5: Base Case Characteristics of International Futures

International Futures Base Case Characteristic – Version 6.43								
Economy	**Population**	**Education**	**Health**	**Government**	**Technology**	**Agriculture**	**Energy**	**Environment**
Global GDP growth ranges from 3-4% annually	Fertility rates decline in all regions	Primary education gross enrollment is over 100% by 2025	AIDs deaths fall to less than 1 million people annually by 2040	Political freedom increases at the global level	Energy efficiency improves at .5% annually	Cereal yields improve globally at about 0.03 tonnes per hectare per year	Energy from oil, gas and coal dominate global production for the next two decades	Annual carbon emissions grow for the next 2 decades then plateau

Economic production continues to diversify towards services and ICT	Life Expectancy improves in all regions	Secondary gross enrollment levels reach 80% by 2025	Communicable disease deaths decrease by half over 35 years	Economic freedom increases at the global level	Energy production costs decrease exogenously differently for each type covered (coal, oil, gas, hydro, nuclear and other-renewable)	Overall crop land increases by about 1 million hectares per year	Renewable energy production surpasses any single fossil fuel by 2040	Carbon buildup in the atmosphere grows throughout the first half of the 21st century going beyond 500 PPM by 2050
International trade as a percentage of GDP ticks up about 0.5 percentage points annually	Migration trends are extrapolated from historic patterns	Tertiary gross enrollment is over 30% by 2025	Non-communicable disease deaths increase 1.5 times over 35 years	Democracy improves	Global convergence of productivity to system leader in technology	Overall grazing land increases by about 2 million hectares per year	Hydrogen and nuclear energy production stagnate	

Foreign Direct Investment as a percentage of GDP increases at nearly 0.04 percentage points annually		World literacy levels are over 90% by 2030	Global smoking rates decline to the level in 1980 in 25 years	Corruption is reduced		Overall fish harvest remains constant			
Foreign Aid more than doubles in 40 years from 6 trillion USD to over 12 trillion				Efficacy and Rule of Law are improved					

Appendix 6: Fresh Water Renewable Resources Percent Used in 2050

Countries Ranked By Water Stress in 2050 with Percent Water Stress Shown			
1 - Kuwait	7,418	29 - Taiwan	53.77
2 - UAE	1,555	30 - India	50.21
3 - Saudi Arabia	1,190	31 - Belgium	41.87
4 - Libya	1,029	32 - Macedonia	37.22
5 - Palestine	671.1	33 - Kazakhstan	36.64
6 - Yemen	398.1	34 - Lebanon	35.1
7 - Qatar	334.2	35 - Spain	34.29
8 - Oman	201.4	36 - Zimbabwe	33.45
9 - Jordan	190.7	37 - Bulgaria	31.92
10 - Turkmenistan	163.3	38 - Armenia	31.18
11 - Israel	157.2	39 - Mauritania	29.67
12 - Uzbekistan	149.3	40 - Mauritius	29.55
13 - Egypt	145.3	41 - Sri Lanka	29
14 - Tajikistan	116.9	42 - Ukraine	28.51
15 - Syria	114.3	43 - South Africa	28.5
16 - Iraq	112.6	44 - Cyprus	27.44
17 - Sudan	105.1	45 - USA	26.75
18 - Afghanistan	82.17	46 - Korea South	25.62
19 - Iran	81.02	47 - Timor-Leste	24.73
20 - Tunisia	77.87	48 - Germany	24.61
21 - Kyrgyzstan	74.62	49 - Thailand	22.72
22 - Pakistan	74.6	50 - China	22.44
23 - Azerbaijan	70.63	51 - Italy	21.14
24 - Swaziland	59.11	52 - Moldova	20.79
25 - Morocco	58.47	53 - Turkey	20.7
26 - Algeria	58.39	54 – Dominican Republic	20.67
27 - Puerto Rico	58.38	55 - Hungary	20.56
28 - Somalia	56	56 - Cuba	20.18

Appendix 7: Government Risk Index scores for countries in 2010 and 2050

Government Risk Index Most Unstable to Least			
2010		2050	
Somalia	0.545	Somalia	0.484
Afghanistan	0.496	Congo, Democratic Republic of	0.443
Congo, Democratic Republic of	0.489	Afghanistan	0.385
Angola	0.483	Chad	0.384
Sudan	0.475	Myanmar	0.377
Chad	0.467	Burundi	0.365
Myanmar	0.454	Eritrea	0.364
Eritrea	0.441	Central African Republic	0.352
Congo, Republic of	0.43	Sudan	0.351
Burundi	0.423	Cote d'Ivoire	0.345
Central African Republic	0.418	Rwanda	0.344
Yemen	0.408	Madagascar	0.343
Nigeria	0.406	Guinea Bissau	0.342
Rwanda	0.405	Mauritania	0.341
Sierra Leon	0.405	Togo	0.341
Equatorial Guinea	0.404	Haiti	0.328
Cote d'Ivoire	0.398	Libya	0.328
Papua New Guinea	0.395	Niger	0.324
Swaziland	0.391	Iraq	0.322
Turkmenistan	0.39	Guinea	0.321
Liberia	0.387	Zimbabwe	0.321
Laos	0.386	Swaziland	0.32
Uganda	0.386	Yemen	0.319
Uzbekistan	0.385	Sierra Leon	0.315
Ethiopia	0.383	Korea North	0.314
Guinea Bissau	0.381	Gambia	0.312
Haiti	0.381	Iran	0.312
Niger	0.381	Congo, Republic of	0.311
Nepal	0.38	Liberia	0.311
Mauritania	0.378	Cameroon	0.31
Gambia	0.377	Tajikistan	0.306
Iraq	0.377	Saudi Arabia	0.304
Burkina Faso	0.376	Laos	0.303

Madagascar	0.376	Angola	0.302
Korea North	0.374	Burkina Faso	0.299
Azerbaijan	0.373	Nepal	0.299
Zimbabwe	0.372	Comoros	0.298
Guinea	0.37	Turkmenistan	0.298
Djibouti	0.369	Uganda	0.298
Pakistan	0.367	Uzbekistan	0.298
Cameroon	0.364	Azerbaijan	0.296
Mozambique	0.363	Papua New Guinea	0.296
Mali	0.362	Pakistan	0.295
Libya	0.358	Belarus	0.292
Togo	0.357	Djibouti	0.291
Algeria	0.355	Equatorial Guinea	0.29
Cambodia	0.355	Gabon	0.29
Iran	0.353	Syria	0.29
Gabon	0.352	Vietnam	0.29
Tajikistan	0.351	Kuwait	0.287
Zambia	0.349	Solomon Islands	0.286
Vietnam	0.346	Senegal	0.284
Saudi Arabia	0.343	Algeria	0.283
Timor-Leste	0.341	Benin	0.282
Malawi	0.339	Egypt	0.281
Russia	0.339	Venezuela	0.281
Syria	0.339	Bosnia	0.28
Tanzania	0.339	Zambia	0.28
Comoros	0.338	Kazakhstan	0.278
Lesotho	0.337	Ethiopia	0.277
India	0.336	Morocco	0.277
Senegal	0.336	Mali	0.276
China	0.335	Palestine	0.275
Kuwait	0.335	Fiji	0.274
Solomon Islands	0.331	Russia	0.274
Philippines	0.33	Cambodia	0.273
Bangladesh	0.329	Federated States of Micronesia	0.271
Belarus	0.328	Colombia	0.27
Kazakhstan	0.327	Malawi	0.269
Oman	0.326	Honduras	0.268
Egypt	0.324	Sao Tome and Principe	0.268

Colombia	0.323	Tunisia	0.268
Sri Lanka	0.322	Cuba	0.267
Venezuela	0.322	Philippines	0.267
Guatemala	0.318	Sri Lanka	0.267
Palestine	0.315	Lesotho	0.264
Kenya	0.314	China	0.263
Namibia	0.313	Guatemala	0.262
Fiji	0.311	Tonga	0.262
Morocco	0.31	Jordan	0.261
Thailand	0.309	Nicaragua	0.261
Benin	0.308	Nigeria	0.26
Indonesia	0.307	Thailand	0.26
Sao Tome and Principe	0.305	Bahrain	0.258
Maldives	0.304	Oman	0.256
Federated States of Micronesia	0.303	UAE	0.256
Bahrain	0.302	Kyrgyzstan	0.253
Honduras	0.301	Kenya	0.251
Cuba	0.297	Armenia	0.247
Qatar	0.295	Maldives	0.247
Tunisia	0.295	Mozambique	0.247
UAE	0.295	Paraguay	0.245
Bhutan	0.293	Tanzania	0.245
Bolivia	0.293	Namibia	0.243
South Africa	0.292	Qatar	0.243
Ecuador	0.291	Ecuador	0.24
Jordan	0.291	Timor-Leste	0.239
Kyrgyzstan	0.291	Bangladesh	0.238
Bosnia	0.29	Ghana	0.237
Paraguay	0.289	Indonesia	0.237
Nicaragua	0.287	Guyana	0.236
Ghana	0.286	India	0.231
Turkey	0.283	Georgia	0.23
Vanuatu	0.283	Samoa	0.23
Guyana	0.277	Serbia	0.23
Botswana	0.275	Vanuatu	0.23
Tonga	0.275	Bolivia	0.229
Mongolia	0.274	Ukraine	0.229
Armenia	0.273	Lebanon	0.228

Samoa	0.273	Moldova	0.228
Peru	0.272	Turkey	0.228
Lebanon	0.271	El Salvador	0.223
Belize	0.264	Bhutan	0.222
Georgia	0.264	Mongolia	0.222
Suriname	0.264	Bulgaria	0.221
Trinidad	0.262	South Africa	0.221
Brunei	0.261	Mexico	0.22
Dominican Republic	0.261	Montenegro	0.22
Mexico	0.258	Albania	0.218
Ukraine	0.258	Jamaica	0.218
Grenada	0.257	Belize	0.217
Moldova	0.256	Grenada	0.217
El Salvador	0.255	Puerto Rico	0.216
Albania	0.254	Cape Verde	0.214
Cape Verde	0.254	Macedonia	0.214
Malaysia	0.252	Botswana	0.213
Puerto Rico	0.252	Brunei	0.213
Brazil	0.247	Suriname	0.211
Macedonia	0.246	Hong Kong	0.209
Serbia	0.246	Peru	0.208
Jamaica	0.244	Singapore	0.208
Montenegro	0.242	Brazil	0.207
Bulgaria	0.239	Malaysia	0.207
Argentina	0.237	Trinidad	0.207
Israel	0.237	St. Vincent and the Grenadines	0.206
Panama	0.237	Romania	0.205
Singapore	0.233	Israel	0.204
St. Lucia	0.229	Dominican Republic	0.203
St. Vincent and the Grenadines	0.227	Costa Rica	0.196
Romania	0.225	Croatia	0.194
Croatia	0.223	Panama	0.193
Costa Rica	0.221	St. Lucia	0.193
Hong Kong	0.218	Argentina	0.191
Latvia	0.215	Greece	0.19
Mauritius	0.214	Lithuania	0.19
Lithuania	0.207	Mauritius	0.19

Chile	0.205	Latvia	0.189
Italy	0.204	Chile	0.188
Greece	0.203	Italy	0.185
Bahamas	0.197	Portugal	0.185
Hungary	0.196	Hungary	0.18
Uruguay	0.196	Barbados	0.178
Malta	0.194	Spain	0.178
Poland	0.193	Uruguay	0.178
Portugal	0.193	Bahamas	0.176
Slovak Rep	0.193	Cyprus	0.174
Czech Republic	0.192	Czech Republic	0.173
Korea South	0.188	Slovak Rep	0.173
Barbados	0.185	Malta	0.172
Estonia	0.185	Slovenia	0.171
Slovenia	0.183	Estonia	0.17
Spain	0.183	Taiwan	0.166
Taiwan	0.183	Belgium	0.165
Belgium	0.181	Poland	0.165
Cyprus	0.181	France	0.163
USA	0.179	Korea South	0.161
France	0.177	Australia	0.159
Iceland	0.177	USA	0.159
United Kingdom	0.174	New Zealand	0.156
Ireland	0.171	Iceland	0.155
Japan	0.169	Japan	0.155
Norway	0.169	Netherlands	0.154
Australia	0.167	Ireland	0.153
Luxembourg	0.167	Luxembourg	0.153
Netherlands	0.167	Austria	0.152
Austria	0.166	Germany	0.152
Switzerland	0.165	Norway	0.15
Canada	0.164	Switzerland	0.15
Germany	0.162	United Kingdom	0.15
New Zealand	0.159	Canada	0.149
Denmark	0.157	Denmark	0.146
Finland	0.155	Finland	0.144
Sweden	0.153	Sweden	0.143

Appendix 8: Multivariate Regression Used To Forecast Political Embeddedness in International Political Organizations

Dependent Variable	=	**Political Embeddedness in International Political Organizations**
Independent Variable 1	=	GDP per capita at PPP
Independent Variable 2	=	Gov Expense % GDP
Independent Variable 3	=	Historic Material Power
Coef_of_X1:	=	1.884102
Coef_of_X2:	=	1.438121
Coef_of_X3:	=	16.10293
Y Intercept	=	58.8817
R-Square	=	0.610311
Adj R-Square	=	0.593368
F-Value	=	36.02139
Probability of Zero	=	4.00E-14
SE of Y-Intercept	=	10.84787
SE_of_X1:	=	0.423389
SE_of_X2:	=	0.459673
SE_of_X3:	=	3.391678
Beta_of_X1:	=	0.413867
Beta_of_X2:	=	0.284317
Beta_of_X3:	=	0.367212
t-Value of Y-Intercept	=	5.427949
t-Value_of_X1:	=	4.450054
t-Value_of_X2:	=	3.128574
t-Value_of_X3:	=	4.747779
Prob of Y-Intercept	=	7.98E-07
Prob_of_X1:	=	3.21E-05
Prob_of_X2:	=	2.57E-03
Prob_of_X3:	=	1.08E-05
Multiple R	=	0.781224
Std Error of Estimate	=	31.55091
Dependent Variable Ave	=	99.76284
Dependent Variable	=	48.63065

Standard Deviation		
Dependent Variable Coefficient of Variation	=	0.487463
Ratio of SE to Mean	=	0.316259

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